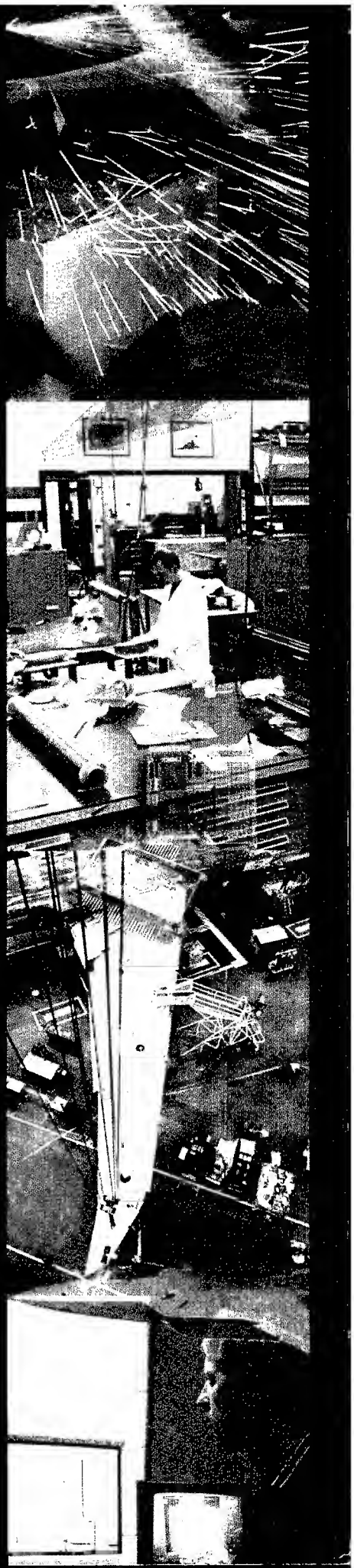
AIR FORCE MANUFACTURING TECHNOLOGY

A DIGEST OF THE AIR FORCE'S MANTECH ACTIVITIES

2001 Project Book



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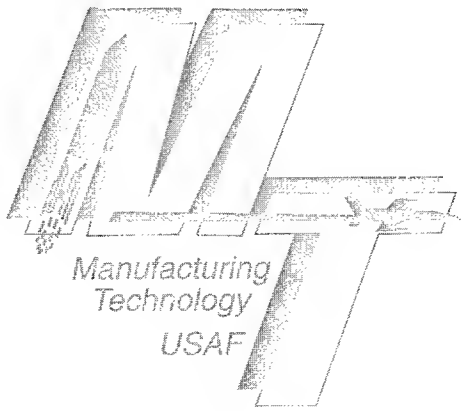


Advanced Manufacturing and Modeling Simulation

Contract Number: F33615-98-D-5128
Project Engineer: Jon Jeffries
Contractor: DaySys Incorporated
Current Status: Active
Start Date: June 1998 End Date: June 2001

Objective

Establish, exploit, and advance the potential of the technology and methods available within the Product Affordability & Realization Testbed (PART), and to apply PART technology and methods to Air Force Research Laboratory (AFRL) Manufacturing Technology Division (MLM) programs.

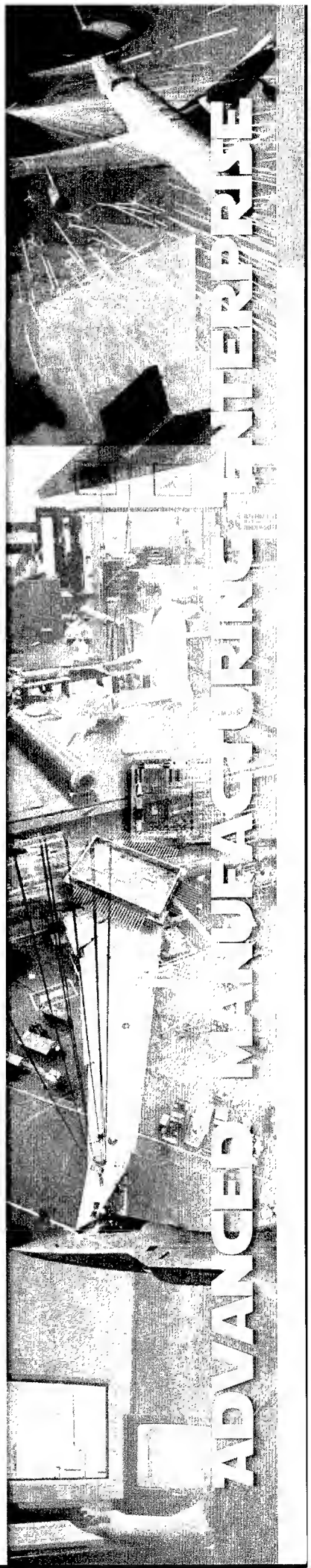
The Manufacturing Technology Division identifies, develops, and demonstrates new computer-based technologies and processes that enhance affordability by working with methods and tools that improve product design and process development efficiencies for manufacturing weapon systems. The Product Affordability & Realization Testbed (PART) provides a flexible research facility that can develop, assess, and implement computer-based tools that identify costs and risks, perform cycle time analysis, reduce errors, and implement lean principles. The PART is a computer testbed used to conduct experiments demonstrating a broad array of manufacturing software technologies and information tools which support and enhance Integrated Product and Process Development (IPPD).

The contractor will perform a wide range of technical activities in the area of weapon system affordability and manufacturing risk reduction. These activities include software and hardware tool evaluation, system analyses, risk and integration studies, technology transition and training, design engineering, prototyping, and engineering testing.

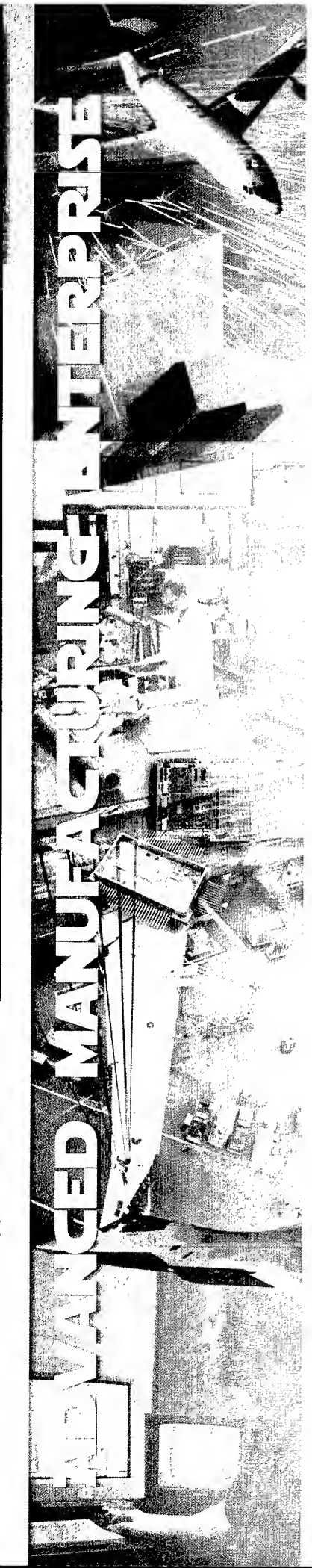
Delivery of the Stratasys FDM (Fused Deposition Modeling – a solid freeform fabrication technology which involves digitally slicing a 3D model of a part and then building a prototype of the part by extruding a thermoplastic polymer layer-by-layer) 2000 was completed. Activities focused on installation, training and operation associated with the Stratasys FDM 2000. An FDM model of a corner reflector was designed and produced in support of AFRL optics work. A process tracking form was developed for projects using the FDM machine. The form enables the tracking of material, time, process problems and other pertinent information required to evaluate the FDM machine.

Benefits

Provide improved modeling and simulation tools for use in the design and development process of manufacturing affordable weapon systems.



For more information on this project, contact the Manufacturing Technology Division's Technical Information Center at (937) 256-0194. Refer to #1887.



Affordable Space Systems Intelligent Synthesis Technology (ASSIST) for Manufacturing

Cooperative Agreement Number: F33615-99-2-5902
Project Engineer: Cliff Stogdill
Contractor: Lockheed Martin Space Systems
Current Status: Active
Start Date: May 1999 End Date: August 2001

Objective

Lower space system acquisition cost through cycle time reductions. Specific milestones are to: develop and deploy the ASSIST framework and tools based on user requirements; validate and demonstrate identified goals of cost, cycle time, and risk reductions by applying the ASSIST technology to the A2100 satellite propulsion subsystem through pilot programs; transition improvements achieved on A2100 to other end users such as USAF Space Based Infrared Systems (SBIRS), Wideband Gapfiller, Advanced EHF, and classified programs; and disseminate pilot results to end users and establish a plan to migrate validated tools to the space systems manufacturing community through commercialization. Low volume production associated with space systems manufacturing is inherently expensive, time consuming, and risk-laden. Typical characteristics of low volume manufacturing such as lack of standard design and common parts, frequent changes to design, costly test environments, and loosely coupled product teams, including suppliers, are obstacles to achieving space systems affordability. At the root of this problem is an inability to adequately predict, monitor, and control the product development and sustainment process. Analysis of these problems revealed that they stem from deficiencies in information technology and management.

Benefits

Reduction in space system procurement costs by 10-15 percent; reduction in design cycle time, manhours for test, exposure to hazardous operations, and launch site test support hours by 50 percent; and reduction of rework hours to five percent of total manufacturing hours.

Manufacturing Technology USAF

For more information on this project, contact the Manufacturing Technology Division's Technical Information Center at (937) 256-0194. Refer to #2562.

An Adaptable Environment for Parts Obsolescence Management

Cooperative Agreement Number: F33615-98-2-5148
Project Engineer: Cliff Stogdill
Contractor: The Analytical Sciences Corporation
Current Status: Complete
Start Date: September 1998 End Date: June 2000

Objective

Provide the obsolete parts management community with decision support tools and an integrated business process for making cost-effective obsolete parts management decisions based on consideration of all the relevant variables. The management of obsolete parts within the DoD and specifically the Air Force is a large and growing problem caused by the rapid evolution of electronics technologies within the commercial sector, coupled with long DoD production cycles and life extension programs. The problem is exacerbated by inventory reductions and personnel cuts being felt within the logistics support structure. Similar problems also exist with non-electronic parts as aircraft structures continue to age well past their expected life cycles.

TASC delivered a Parts Obsolescence Management Roadmap that will assist system managers by providing the information (tools/processes) necessary to determine the most cost-effective parts obsolescence solution with consideration of many variables. TASC also adapted their existing Resource Allocation Decision Support System (RADSS) as a stand-alone PC-based program to accommodate unique aspects of the obsolete parts management problems. The resulting tool will provide obsolete parts managers, both government and commercial, with a usable decision support system for enhancing parts obsolescence decisions.

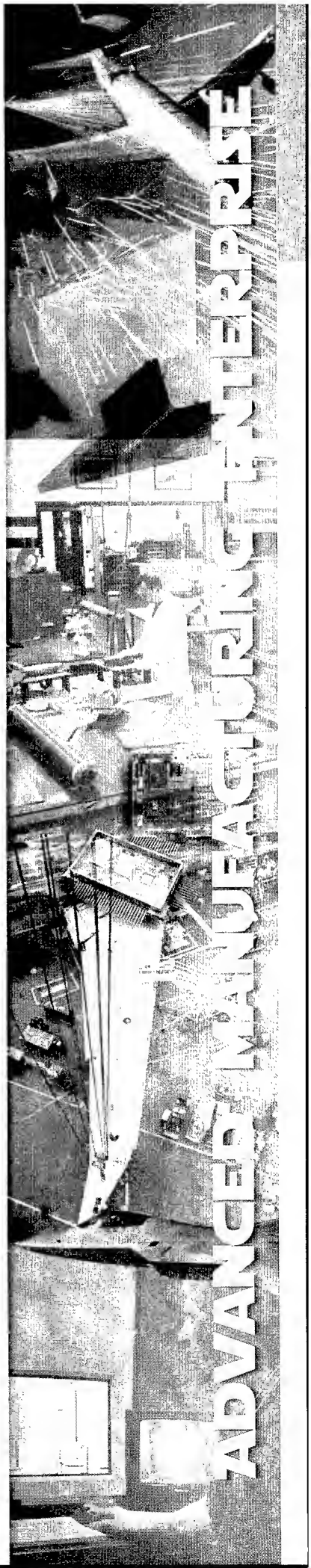
The Parts Obsolescence Management Roadmap provides an integrating vision that takes advantage of currently available tools and information. It also identifies the opportunities for focusing future research activities. The Parts Obsolescence Management Decision Support System meets the critical need for decision support tools flexible enough to address several obsolete parts management decisions, and takes advantage of available information and management insights at various levels of aggregation. Together, these elements significantly improve the current state-of-the-practice associated with parts obsolescence management.

Benefits

Provided a decision support system to assist managers in making cost effective obsolete parts management decisions on aircraft electronic systems.

Manufacturing Technology USAF

For more information on this project, contact the Manufacturing Technology Division's Technical Information Center at (937) 256-0194. Refer to #1889.



Control Stick of the 21st Century (CS21)

Contract Number: F33615-00-C-5518
Project Engineer: David Judson
Contractor: Essex Industries Incorporated
SBIR Funded
Current Status: New Start
Start Date: March 2000 End Date: December 2000

Objective

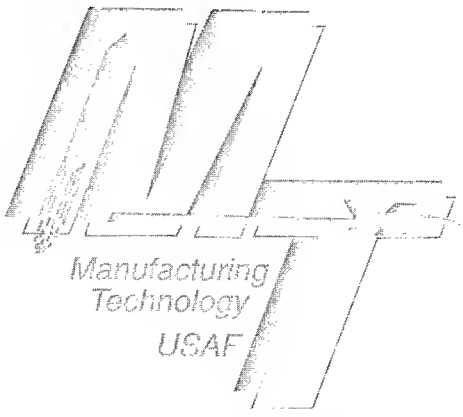
Design and develop the control stick of the future while considering the requirements to potentially retrofit the CS21 stick technology into aircraft currently in development and production.

This is a project initiated by the F-22 System Program Office (SPO) for the redesign and reengineering of the stick used by the pilot to control the aircraft. The size and complexity of the current stick technology must be drastically reduced in order to provide more functionality and improved human factors considerations. The switch bodies are huge and this causes the stick and throttle grips to be very large. More functionality is needed at the pilot's fingertips in order to improve the pilot's performance during flight and warfighting. The current stick technology user friendliness and other human factors also leave a lot to be desired.

Phase I of this project is in progress and an in-depth technical review with the SPO and the F-22 and JSF weapon system contractors is scheduled. This study potentially leads to the design and manufacture of actual CS21 Control Stick and Throttle retrofit versions for F-22 and JSF weapon systems and commercial aircraft. This project is on schedule and progressing well technically. Phase I will produce community accepted CS21 functional requirements specifications, prioritize alternative solutions, and design and develop three-dimensional models, implementing the proposed component, and shape and human factor improvements.

Benefits

Provide: 1) increased ease of use in the control stick and throttle; 2) reduction in throttle grip size by 70 percent; 3) consideration of human factors in placement and angle of the stick grip; 4) reduction in switch size by 40 percent; 5) increase in the number of switches; 6) increase the functions on switches by 20 percent; and 7) increased pilot assistance via software in the control stick and throttle operations.



For more information on this project, contact the Manufacturing Technology Division's Technical Information Center at (937) 256-0194. Refer to #2884.

Control Stick of the 21st Century (CS21)

Contract Number: F33615-00-C-5519
Project Engineer: David Judson
Contractor: Stirling Dynamics Incorporated
SBIR Funded
Current Status: New Start
Start Date: March 2000 End Date: December 2000

Objective

Design and develop the control stick of the future while considering the requirements to potentially retrofit the CS21 stick technology into aircraft currently in development and production.

This is a project initiated by the F-22 System Program Office (SPO) for the redesign and reengineering of the stick used by the pilot to control the aircraft. The size and complexity of the current stick technology must be drastically reduced in order to provide more functionality and improved human factors considerations. The switch bodies are huge and this causes the stick and throttle grips to be very large. More functionality is needed at the pilot's fingertips in order to improve the pilot's performance during flight and warfighting. The current stick technology user friendliness and other human factors also leave a lot to be desired.

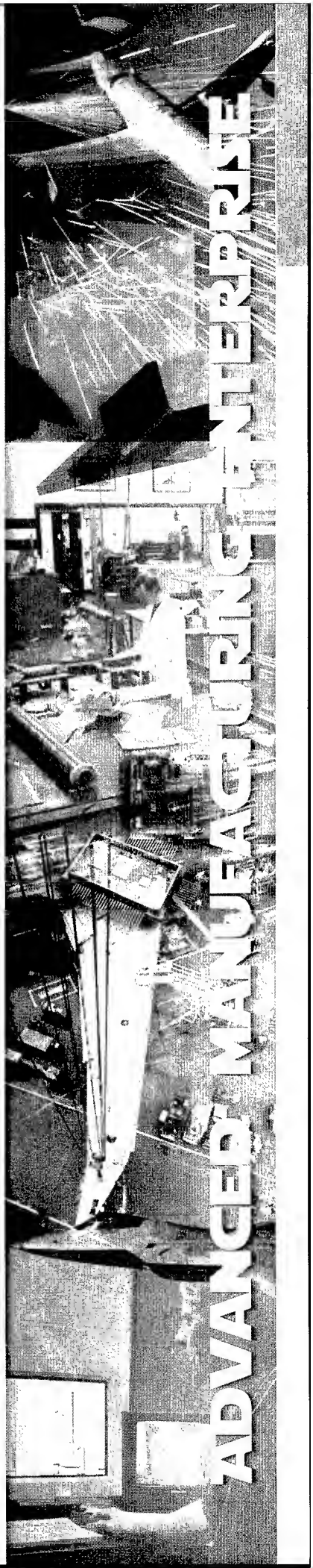
Phase I of this project is in progress and an in-depth technical review with the SPO and the F-22 and JSF weapon system contractors is scheduled. This study potentially leads to the design and manufacture of actual CS21 Control Stick and Throttle retrofit versions for F-22 and JSF weapon systems and commercial aircraft. This project is on schedule and progressing well technically. Phase I will produce community accepted CS21 functional requirements specifications, prioritize alternative solutions, and design and develop three-dimensional models, implementing the proposed component, and shape and human factor improvements.

Benefits

Provide: 1) increased ease of use in the control stick and throttle; 2) reduction in throttle grip size by 70 percent; 3) consideration of human factors in placement and angle of the stick grip; 4) reduction in switch size by 40 percent; 5) increase in the number of switches; 6) increase the functions on switches by 20 percent; and 7) increased pilot assistance via software in the control stick and throttle operations.

Manufacturing Technology USAF

For more information on this project, contact the Manufacturing Technology Division's Technical Information Center at (937) 256-0194. Refer to #2883.



Create A Process Analysis Tool Kit for Affordability Supporting the R&D Process

Contract Number: F33615-97-C-5141
Project Engineer: David Judson
Contractor: James Gregory Associates
SBIR Funded
Current Status: Active
Start Date: September 1997 End Date: August 2001

Objective

Develop, validate, and commercialize a high-quality process analysis toolkit. The Process Analysis Toolkit for Affordability (PATA) must enable life cycle performance cost and schedule affordability analyses, both during the research and development phase of Air Force technology development and during subsequent technology transition to acquisition and support. This effort is specifically focused on applying integrated product process development (IPPD) principles to defense research and supporting the Science and Technology (S&T) IPPD initiative and business processes throughout the Air Force laboratory environment.

One of the hurdles in applying integrated product process development (IPPD) to new technology is quantifying the transition cost and risk impact of critical design or architecture decisions. Determining how risk can be quantified for new technologies, how to base design decisions on process capabilities that aren't fully defined, and how to achieve in software the results being realized in electronics manufacturing, are questions which need to be answered. PATA is a development and commercialization project, intended to be used by the Air Force S&T community, including industry, academe, and government, to ensure research and development projects have viable, usable and affordable results. The project will use a technical review board to remain abreast of industry requirements and developments. The PATA tools will be launched from the web site for testing and then commercialization. PATA system and training developed will be beta tested by Air Force Material Command Advanced Technology Demonstration (ATD) projects.

JGA has extended the PATA capability to be web-enabled as the electronic Process Analysis Toolkit for Affordability (ePATA). Commercial application of the ePATA tools is occurring under private funding. The tools exist and are operational in the Air Force Product Affordability Realization Testbed (PART) and from a JGA, Inc. website. There are 13 Air Force Advanced Technology Demonstration program pilot sites using the PATA tools. Hundreds of Air Force and other agency personnel have been trained on the PATA tools. New requirements, additional interfaces and training developments were determined and many funded; extending the contract. PATA is inexpensive and uses unique Internet browser technology and related standards making it convenient and easy to use.

Benefits

Provide a credible, high-quality tool to use when making cost and affordability decisions during weapon system research, development and acquisition. PATA use has led to decisions that reduced design cycle time for advanced engine turbine blades from three months to two weeks, and reduced down stream deployment costs for defensive countermeasures systems by more than 50 percent, saving several hundred million dollars. An Army project came in 25 percent under cost and 20 percent ahead of schedule.

For more information on this project, contact the Manufacturing Technology Division's Technical Information Center at (937) 256-0194. Refer to #1569.

Demand Pull Supplier Pilot (DPSP)

Cooperative Agreement Number: F33615-00-2-5900
Project Engineer: James Poindexter
Contractor: Boeing Company
Current Status: New Start
Start Date: April 2000 End Date: May 2004

Objective

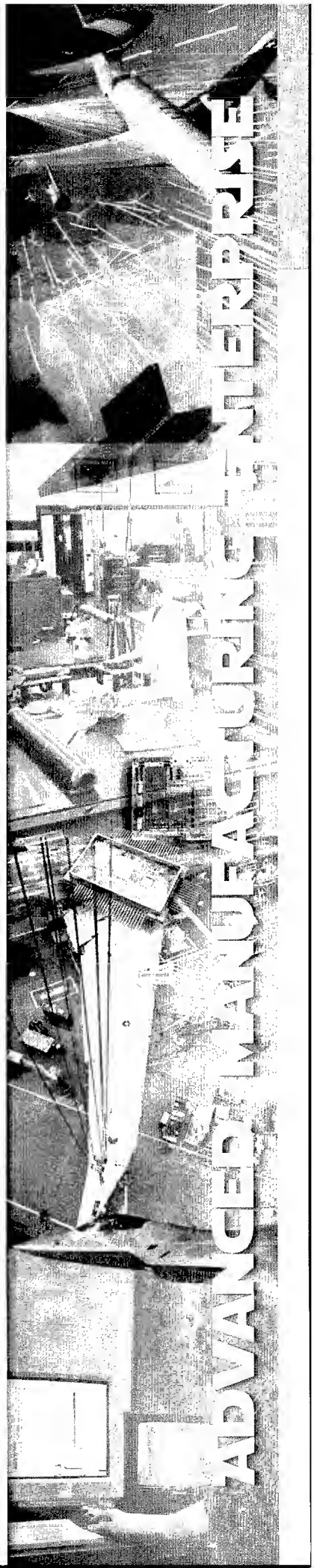
Demonstrate affordability and producibility benefits for Air Force weapon systems through the development, application and transition of Lean Enterprise concepts, specifically, demand pull systems, applied to Boeing's second and third tier munitions suppliers. As much as 70 percent of the value of defense systems and major subsystems is borne in the supply chain, and the percentage continues to grow with increased outsourcing of both fabrication and subassembly. Industrial base assessment data clearly show that smaller suppliers tend to lack the capabilities needed to respond to demands for affordability and quality improvements or to properly discharge the increased responsibilities being delegated by their customers. Small businesses may be unable to cope with the need to change due to a lack of capital or a lack of technical resources, or both. For larger firms to provide needed support to these small and medium sized enterprises (SMEs), a cogent business case must be proven where the SME, the customer firm, and the government benefit. The Small/Medium Enterprise Initiative (SMEI) is focused on driving affordability concepts throughout the supply base by stimulating improvement in SMEs where those improvements benefit an Air Force weapon system program.

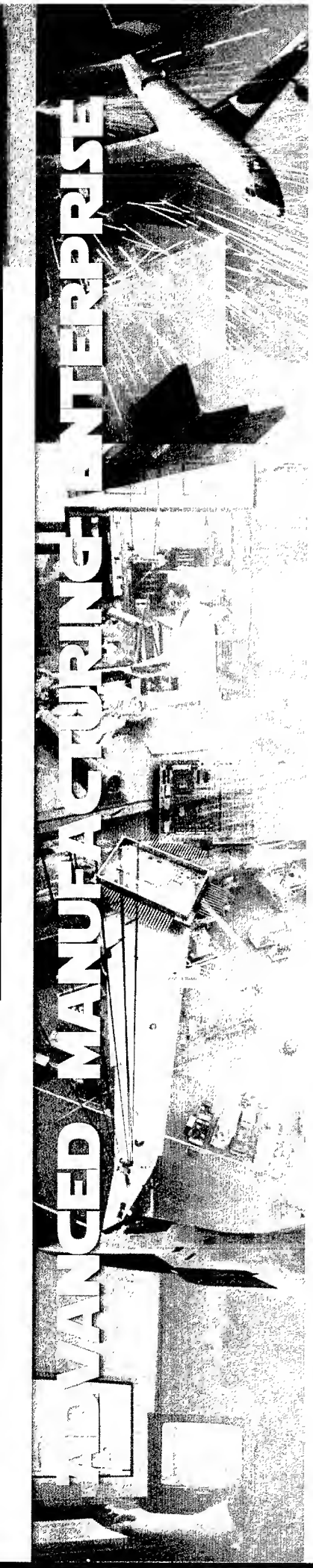
Boeing will identify a key set of small and medium sized munitions suppliers, conduct a value stream analysis of their critical processes, identify areas for improvement and train supplier personnel in lean manufacturing techniques. Process improvements will be implemented based on the value stream analyses and benefits tracked. Project gains will be shared to provide measurable benefit to the supplier, the original equipment manufacturer, and the government customer. The first visit to each SMEI will consist of Lean training over a three-day period. Major training elements will include Lean Overview, Lean Diagnostic, Strategic Context, and initial Value Stream Mapping. During the second visit to each SMEI supplier, baselining the current state will be the initial activity. After this is complete, a value stream map will be created followed by Accelerated Improvement Workshop (AIW) targeting. The third visit will concentrate on development of an AIW roadmap as well as AIW training and team selection. The initial cycle is completed in the fourth visit when the AIW is performed

Benefits

Provide improvement in small and medium sized enterprises which will create a stronger supplier base providing higher quality, lower cost components for munitions. Lessons learned form this effort will be transitioned to additional small and medium suppliers through a focused set of annual workshops, training materials and project reports.

For more information on this project, contact the Manufacturing Technology Division's Technical Information Center at (937) 256-0194. Refer to #2672.





Enterprise Synchronous Manufacturing and Investments (ESMI)

Cooperative Agreement Number: F33615-99-2-5100
Project Engineer: Alan Herner
Contractor: Boeing Company
Current Status: Active
Start Date: May 1999 End Date: June 2002

Objective

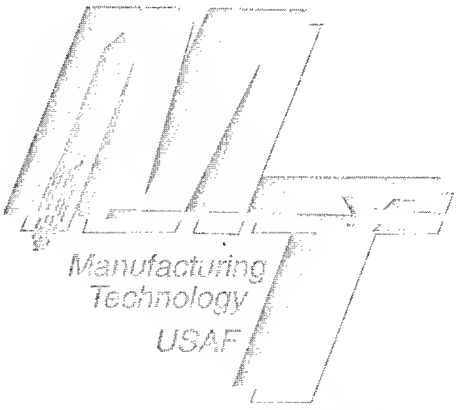
Achieve both a 50 percent reduction in the cost of selected components, and a 50 percent reduction in cycle time, to support technology affordability in the space sector. Low-volume space systems production presents unique challenges. There are opportunities to learn from the commercial spacecraft producers and address special spacecraft affordability and operability issues. This effort is targeting top-level space enterprise and manufacturing processes to reduce cost and cycle times while improving quality.

The approach is to develop a virtual corporation to create and distribute breakthroughs in design and manufacturing for space systems. Two projects are to be completed under this program: The first is developing enterprise level techniques. The second is developing and demonstrating factory floor process improvements. The enterprise level investments include: a demonstration of synchronous manufacturing within an engine duct; supply chain integrated manufacturing; reduced satellite testing; factory layout, simulation and visualization and lean enterprise technical program management. The factory floor process improvements include improved infrared Focal Plane Arrays and low-cost reusable composite propellant tanks.

The program is currently conducting a demonstration of the enterprise level techniques on an engine duct cell. Demonstrations of the factory level improvements are planned for 2001.

Benefits

Provide significant improvement in affordability of critical elements of space systems, reducing cost and manufacturing cycle times by half for several key processes. In addition, this project will accelerate supplier collaboration with space sector original equipment manufacturers in design and manufacturing processes.



For more information on this project, contact the Manufacturing Technology Division's Technical Information Center at (937) 256-0194. Refer to #2617.

Flexible Environment for Conceptual Design

Contract Number: F33615-96-C-5617
Project Engineer: Dr. Gene Himes
Contractor: Rockwell International Corporation
DARPA Funded
Current Status: Complete
Start Date: June 1996 End Date: June 2000

Objective

Develop and demonstrate an integrated set of flexible engineering analysis and design tools for supporting conceptual design of complex engineering systems. This project sought to build a computer environment that can tightly integrate analysis across multiple disciplines. It has the flexibility to let the analyst quickly explore new opportunities as they arise by making it as simple as possible to extend and/or modify analysis models.

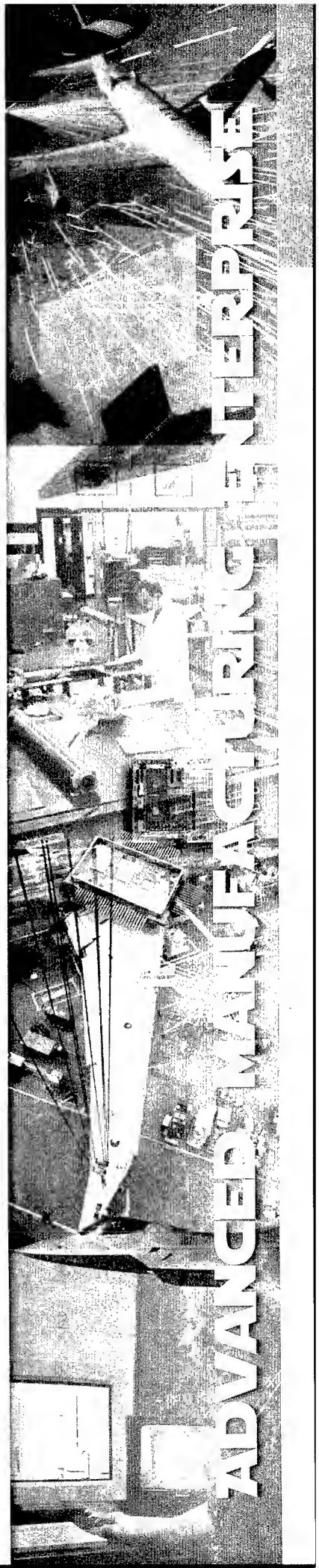
This effort included research and development in design and analysis methods with particular emphasis on constraint management and nonlinear solution methods. Challenging design exercises on Department of Defense relevant systems were undertaken in conjunction with the Navy Aegis LEAP (Lightweight Exo-Atmospheric Projectile) and the U.S. Air Force TAV (Trans-Atmospheric Vehicle) programs using the integrated prototype software to evaluate its capabilities and limitations.

Based on feedback from Design Sheet users on DoD specific programs, it was apparent that a significant conceptual design producibility enhancement would be effected if constraint management technology were available in common spreadsheet environments. Rockwell Science Center requested and was granted a no cost time extension to the contract to determine the feasibility of connecting the algebraic constraint management system incorporated in Design Sheet as a back-end to a traditional spreadsheet program such as Excel. The effort involved research of the appropriate bridging technologies as well as mechanisms for extending a normal spreadsheet forward computational plan into directionally independent constraint networks.

Benefits

Developed an advanced design environment that allows for ten times as many design alternatives to be considered during the early stages of a weapon system design program. This environment provides unique support for multi-disciplinary trade-off analyses and design-to-cost studies. Tools developed in this program are focused on the earliest stages of the design where the value of a good design decision has the greatest leverage.

For more information on this project, contact the Manufacturing Technology Division's Technical Information Center at (937) 256-0194. Refer to #1484.



In Situ Design Cost Trades for Affordability

Contract Number: F33615-00-C-5902
Project Engineer: David Judson
Contractor: Mississippi State University
Current Status: New Start
Start Date: July 2000 End Date: November 2003

Objective

Develop an automated method for affordable in situ (in-place) design cost trade (IDTC) studies. The IDCT capability will be designed and developed as a web-based open system to facilitate ease of use and enable the addition of capabilities as required. The initial IDCT system will include a cost-evaluation framework, a piece parts cost trades capabilities, taxonomy and classification of materials and process utilities, and a dictionary / repository. This will enable life cycle design decision-making processes by providing an effective means for addressing requirements and cost against performance of candidate design alternatives. IDCT affordability trade studies will be life-cycle based and support mission performance during the creative and mechanical design processes. IDCT will support individuals and teams, in all stages of the product life cycle. These "on-demand" trade studies begin in the earliest stages of conceptual development and continue through disposal supporting new systems, modifications and updates, subsystems, component and unit levels essential for developing and producing affordable products. Since the design decision making process begins with conceiving and organizing capabilities into possible solutions, it is essential that consideration be given to the cost of mission, materials, processes, tools, labor, operations, support, standards, unions, etc.

The IDCT prototype will evolve and mature as a usable system demonstrating cost evaluations as an integral part of the engineering processes supporting design team activities "cradle to grave." These evaluations will include first article product detail design engineering, mods and updates, operations and support cost. These cost evaluations will be accomplished by analysts, designers, and software agents performing processes in the background on available global network information and the designer's data from the computer aided design workstation, to provide "in place" support to the design engineer during the design process. These trades will be done under configuration management and control as the design is created and evolves. IDCT will capture evolving design experiences, retain design cost information, to reuse, recreate, exploit and analyze for feedback on design experiences. The contractor will use industry (users and vendors), government and other universities to support the project developments. This is a cost share funded project.

Benefits

Provide a means to synthesize, analyze, and determine programmatic changes in design processes, product and costs of a weapon system. IDCT will enable the designer to identify and understand *what* and *how* these variables influence cost and performance. The study phase for feasibility of IDCT capability indicates that 45 percent of acquisition costs and 65 percent of operation and support costs over the life cycle of a weapon system could be avoided with the use of an IDCT suite. The system will provide the tools made available and used by trained strategic managers in Pre-Milestone 0 and in the following Milestones of a weapon system's life cycle.

For more information on this project, contact the Manufacturing Technology Division's Technical Information Center at (937) 256-0194. Refer to #2931.

Integrated Knowledge Environment - Integrated Product Management (IKE-IPM)

Contract Number: F33615-96-C-5109
Project Engineer: David Judson
Contractor: Knowledge Base Engineering Incorporated
SBIR Funded
Current Status: Complete Technical Report No. AFRL-ML-WP-TR-2000-4051
Start Date: May 1996 End Date: January 2000

Objective

Develop a framework for managing acquisition and sustainment projects and processes and for assessing the cost schedule, performance and risk associated with product development. This product satisfies the need for innovative acquisition tailoring and alternative development processes for program management tools and reference libraries that contain standards, handbooks, templates, and guidelines that are accessible over local and wide area networks. It also provides tools that automatically produce tailored project plans and schedules from process model templates that contain systems engineering/ configuration management activities for the various engineering and manufacturing disciplines.

The contractor created a suite of tools called IKE based on the flexible framework in Phase I. IKE tools are integrated and enable project management, process modeling, life cycle cost analysis, and affordability analysis. The contractor used internal funding created from a commercial IKE capability called Object Czar (Oz). Oz provides additional capabilities for maintaining individual and distributed work breakdown structures, organization structure, project structures, etc., and allows users to dynamically define object properties and immediately update them with values without programming.

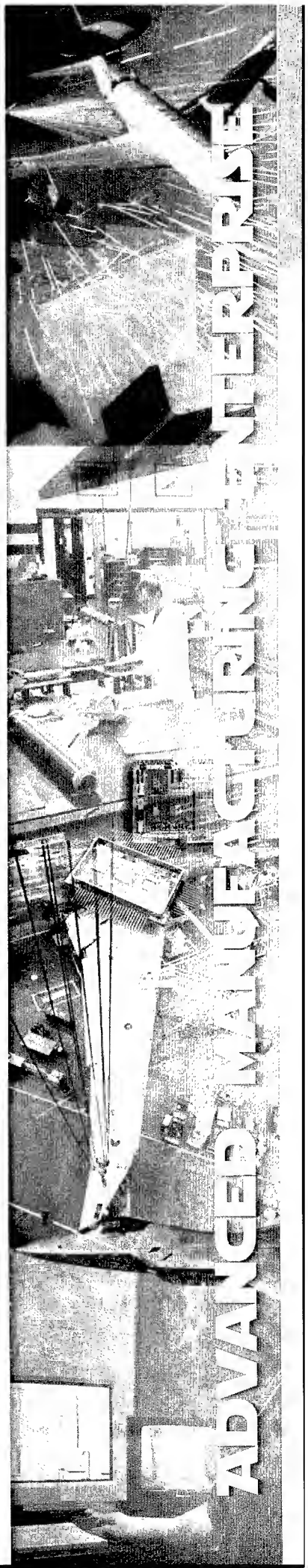
Using Oz, KBE has developed a commercial project management application and has commercial sites operational. The Oz-IPM software has been installed and engineers in the Materials and Manufacturing Directorate have been trained to support 10 pilot test cases. Oz allows users to: create groups of things and establish relationships among them; generate reports rapidly; define roll-up data to determine cost, risk, weight, and other quantitative characteristics; relate metric roll up to colors representations; and sends alarms to management regarding project status associated with process metrics and deliverables.

Another Oz application, the Virtual Manufacturing Enterprise (Oz-VME), provides 170 small manufacturing businesses with a mechanism to facilitate rapid development and distribution of planning and metric information, while facilitating and tracking production status throughout the entire network. Oz operates on top of ISO-OMG standards for dissimilar computing, networks and database requirements and makes them appear as a single system to the end user.

Benefits

Provided a product for managing and assessing the cost performance and risk associated with development of a weapon system. Developers using Oz have experienced a 75 percent increase in productivity in application construction. Application software code is error free since it is generated by the computer and is ready to use in seconds. End users can make extensions to their applications as they use them and without writing code or waiting for a computer person.

For more information on this project, contact the Manufacturing Technology Division's Technical Information Center at (937) 256-0194. Refer to #1462.



Laminated Object Manufacturing-Based Design for Ceramic Composites

Contract Number: F33615-98-C-5121
Project Engineer: Jon Jeffries
Contractor: Northrop Grumman Corporation
DARPA Funded
Current Status: Complete
Start Date: May 1998 End Date: May 2000

Objective

Develop a design process that will enhance the structural efficiency and reduce design time and cost for aerospace Ceramic Matrix Composites (CMC) components. These advantages will accelerate the application of CMC components on advanced Department of Defense (DoD) systems. Current design practice for CMC is hindered by lack of sufficient material property data and by the limited understanding of composite failure behavior. Consequently, CMC designs are overly conservative and expensive, and CMC use in structural applications is limited. A need exists for the development of an innovative design environment in which the use of Laminated Object Manufacturing (LOM) solid freeform fabrication (SFF) will provide significant improvement to the product development cycle for CMC.

This effort consisted of three main tasks: a Design Methodology Development Task for LOM based prototyping, a LOM CMC Process Validation Task, and a CMC Prototype Demonstration Task. The design methodology task contained three related sub-tasks that include software interface development, computer assisted design procedure evaluation, and a design methodology effort. The second task was directed towards extending the capability of the LOM technique to fabrication of large curved shapes typical of large aerospace components and includes CMC material and system process development activities and equipment modifications. The third task involved a demonstration of the usefulness of the LOM-based design method. The modified LOM system was used to fabricate subcomponents designed in the first task. The results from subsequent subcomponent testing were incorporated into the design method database to aid in the design definition of the demonstration component that was designed, fabricated, and tested in the final task. The demonstration component was an engine exhaust washed high temperature blastshield representative of structures anticipated to be used on future military vertical short takeoff and landing (VSTOL) and low observable (LO) aircraft with shielded exhaust.

Benefits

Provided an innovative design environment in which the use of LOM solid freeform fabrication (SFF) provides significant improvement to the product development cycle for CMC. In addition, the effort has developed a design process which improves the structural efficiency, and reduces the design time and cost for aerospace CMC components. Current design practices for CMC are enhanced by the inclusion of more robust material property data and a better understanding of composite failure behavior. These advantages will accelerate the application of CMC components on advanced DoD systems, resulting in greater speed, range, and fuel efficiency.

For more information on this project, contact the Manufacturing Technology Division's Technical Information Center at (937) 256-0194. Refer to #1894.

Lean Aerospace Initiative (LAI), Phase III

Cooperative Agreement Number: F33615-93-2-4316
Project Engineer: John Klempay
Contractor: Massachusetts Institute of Technology
Current Status: Active
Start Date: September 1999 End Date: August 2002

Objective

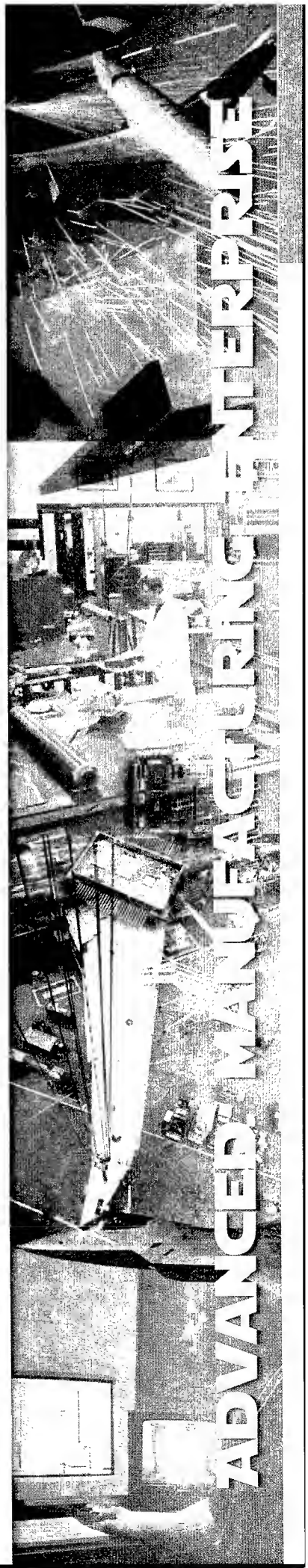
Build on the Lean Aerospace Initiative's strengths and incorporate changes based on lessons learned over the past six years. Phase III efforts are focused on overcoming barriers to implementation, emphasizing best life-cycle value, and leveraging collaborative opportunities. Anticipated products include a Lean Enterprise Self-Assessment Tool, enhancements and extensions of the Lean Enterprise Model (LEM), tailored information to support DoD policy, and enduring products such as books, research publications, documented benefits from adoption of lean concepts within the consortium.

"Lean" is a fundamentally different approach to managing and organizing the enterprise. Most member companies have formulated a program with goals that embrace Lean principles and practices, with primary emphasis on production operations with upstream links to design. Primary Lean targets in government have been the reduction of cycle time for procurement actions and development of seamless information systems. LAI is providing a focus and framework for understanding and adopting Lean. LAI's mission is to enable fundamental change within industry and government operations that supports the continuing transformation of the US aerospace enterprise towards providing aerospace systems offering best life-cycle value. LAI Phase I (Sep 93-Aug 96) established an Executive Board comprised of senior industry, organized labor, and government personnel to assist in steering the effort. Three Lean Forums were conducted in Phase I to transition research findings to the customer base and establish requirements for both technology and acquisition investment planning processes. Based upon MIT LAI research findings, seven advanced manufacturing demonstration projects that piloted the feasibility of lean practice were funded. Industry members used LAI findings and applied Lean practices within their companies, as evidenced during government/industry information exchanges. LAI Phase II (Sep 96-Aug 99) modified the cooperative agreement by extending the period of performance three years and expanding the scope of government and industry participation. The primary means of documenting LAI research findings is through the LEM. Research results are organized to populate the LEM with data on lean practices, metrics, benchmarking information, interactions, key benefits, major barriers, and mitigation strategies. Phase II worked towards a vision of significantly cutting the cost and cycle time for military aircraft while continuing to improve product performance.

Benefits

Unprecedented collaboration between leaders in government, industry, labor and academia resulting in a fundamentally different, provable better way of manufacturing that will better support defense aircraft needs. Research and benchmarking data coupled with the interactions fostered by LAI are powerful agents helping to accelerate the pace of change in industry and government. LAI has added value to the ongoing restructuring, both in the aerospace industrial base and in the acquisition processes used by current and planned programs.

For more information on this project, contact the Manufacturing Technology Division's Technical Information Center at (937) 256-0194. Refer to #1137.



MEREOS - A Product Definition Management System for Enterprise

Cooperative Agreement Number: F33615-95-2-5562
Project Engineer: Jon Jeffries
Contractor: Ontek Corporation
Current Status: Complete
Start Date: December 1994 End Date: January 2000

Objective

Develop and demonstrate, in one or more production environments, a product definition management system based on PACIS®, a next-generation database management system. The goal of the system was to solve the multiple bill of materials reconciliation problem in large-scale, complex product manufacturing environments. The specific objective was to provide end users with the ability to define, modify, query, and automatically maintain relationships between several distinct bills of material (BOMs), specification trees, and functional structures for a single product, where the information involved is stored in geographically distributed heterogeneous databases.

Almost all manufacturing enterprises producing complex products develop separate engineering, manufacturing, and logistical or field support, in order to support various engineering, manufacturing and maintenance activities. Each of these configurations inevitably differ from one another both in form and in content. These differences mark the presence of certain kinds of relations that span bills of material (BOMs). The task of reconciling multiple BOMs for a product involves identifying components that stand in counterpart relations across them, and characterizing the properties of those relations. Establishing counterpart traceability is, in turn, essential for managing engineering change. Managing this process is possibly the most complex and costly activity in a manufacturing enterprise. Identifying and accommodating the ramifications of even a single modification to one component in one product BOM often requires the coordinated expertise of several specialty disciplines, such as materials and process, mechanical, electrical, and software engineering. The multiple BOM phenomenon exacerbates this already difficult problem, since the impacts of changes to a component in one BOM must be determined for all of its counterparts in any other BOMs.

MEREOS can be used in a number of different ways. A systems engineering organization could use it to support automated requirements analysis, decomposition, and traceability. A program management office or product group could use it as the core of a status accounting system. Manufacturing or logistics engineering groups could use the system as an application for defining "as-planned" or "as-supported" structures whose elements must be traceable to "as-designed" components and functional requirements. Finally, an information systems organization could use the system as a tool for update dissemination and database integrity maintenance in environments that have different systems managing different versions of product structures.

Benefits

Provided a system which manages multiple bills of materials in large-scale, complex product manufacturing environments.

For more information on this project, contact the Manufacturing Technology Division's Technical Information Center at (937) 256-0194. Refer to #1370.

Mixed Signal Test (MiST)

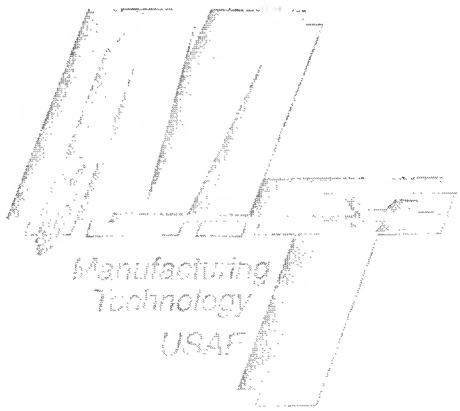
Cooperative Agreement Number: F33615-95-2-5562
Project Engineer: William Russell
Contractor: Boeing Company
Current Status: Active
Start Date: September 1995 End Date: December 2000

Objective

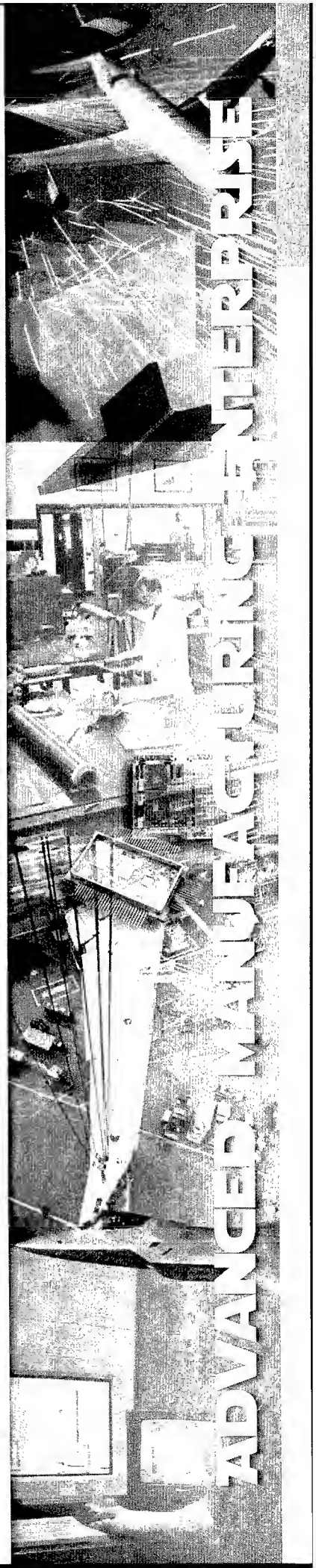
Develop a set of integrated design and test tools for the development of mixed signal multi-chip module and printed circuit board tests. The availability of sub-micron integrated circuit technology and multi-chip modules (MCMs) continues to increase the complexity of analog and mixed-signal designs. Along with this increase in density and complexity come several challenges in developing test prototyping, production, and trouble shooting. The first challenge relates to complexity, density, lack of access to constituent integrated circuits (ICs), and the need for interconnect testing. The second has to do with the specification-driven nature of test procedures for mixed-signal circuits which poses two major problems. First is that under-specified systems, specification testing results in test programs with insufficient analog fault coverage for high quality products. Second is the inability to diagnose an out-of-specification system due to a lack of connection between specifications and component failures. Finally, there is the challenge of having to synchronize digital and analog test resources to test a mixed-signal circuit.

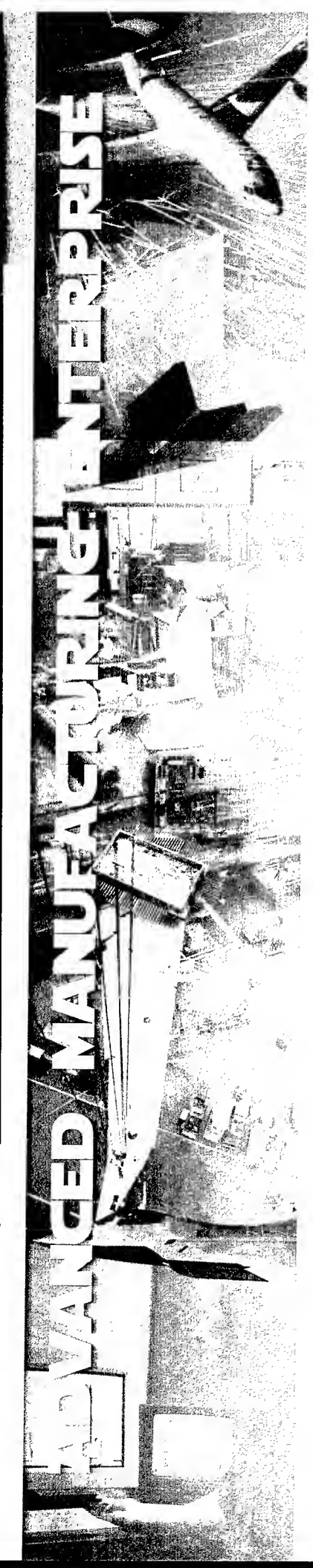
Benefits

Developed a set of design and test tools for mixed signal multi-chip modules and printed circuit boards used in aircraft electronics. The tools are new in beta site use at Boeing and Oklahoma City Air Logistics Center and are lowering the time and cost associated with initial production test and subsequent repair test for mixed signal electronics. Results from the alpha site have yielded 30 percent lower test generation time and costs, with 60 percent better test coverage and diagnostics.



For more information on this project, contact the Manufacturing Technology Division's Technical Information Center at (937) 256-0194. Refer to #1346.





Modular Factory for Electronic Warfare (EW) Component Manufacturing

Cooperative Agreement Number: F33615-95-2-5564
Project Engineer: Brench Boden
Contractor: Northrop Grumman Corporation
Current Status: Complete
Start Date: October 1995 End Date: September 2000

Objective

Demonstrate a modular factory approach to the manufacture of defense products. The program organized a production enterprise into major subassembly elements with technical and business measures for greater efficiency, less waste, lower cost, and greater flexibility. Defense manufacturing is currently accomplished under mass production management methods and procedures, which are inherently inflexible and inefficient for short production runs. The Lean Aircraft Initiative, an industry-government-academia consortium led by the Massachusetts Institute of Technology, is assessing the current state of practice in the defense industry and identifying new directions for improvement. This project applied the leading edge production philosophy of modular flow (as identified by the Lean Aircraft Initiative) to the production of Microwave Power Modules (MPMs).

LAI has identified flow optimization as an enabling practice for the production enterprise. Benchmarking data from the LAI suggests that a modular organization of the factory is a powerful way to improve flow. Demonstration of the modular factory concept for the defense production environment requires consideration of business practice changes, infrastructure improvements, and identification of the barriers and disincentives to its implementation. This lean implementation effort demonstrated the modular factory concept against electronic warfare component manufacture, with emphasis on up-front assessment of cost drivers and affordability concerns.

The modular factory is a reorganization of production resources into modules. Each module has total responsibility for a set of processes which add value to the product. Typically, modules are arranged within the factory around the assembly sequence, with the next higher assembly operation as the customer. The module is characterized by: empowerment of workers and teams, emphasis on training for skill interchangeability, dedicated capital equipment, aggressive inventory reduction, focus on work flow velocity, shop floor density to reduce transportation time, and gain-sharing incentives for employees. Northrop Grumman Electronic Systems and Sensors Sector, Defensive Systems Division, developed a streamlined design-to-manufacturing link. This link includes an automated equipment interface with in-house design tools, a design database, and a networked data link between engineering and manufacturing. These enhancements directly attacked the relationship between cost and volume by minimizing non-recurring engineering costs.

Benefits

Eliminated the costly movement and storage of materials in the production of MPMs for use in aircraft electronics, resulting in a 50 percent reduction in cost and a 50 percent shorter design-to-market cycle time. Some individual set-up processes were reduced by as much as 97 percent. An affordable source of MPMs now exists to support various new and existing systems, upgrades and modifications, and spare requirements.

For more information on this project, contact the Manufacturing Technology Division's Technical Information Center at (937) 256-0194. Refer to #1264.

Parts Obsolescence Management Tool for Out of Production Parts

Contract Number: F33615-98-C-5129
Project Engineer: Theodore Finnessy
Contractor: TRW Incorporated
Current Status: Complete
Start Date: August 1998 End Date: August 2000

Objective

Provide an affordable reengineering model for electronics with supporting computer aided design tools. The model provides for efficient reengineering of an existing design to replace an obsolete part. It includes the ability to reengineer to achieve a new design and to incorporate new or modified functions into a product during reengineering associated with a part obsolescence problem.

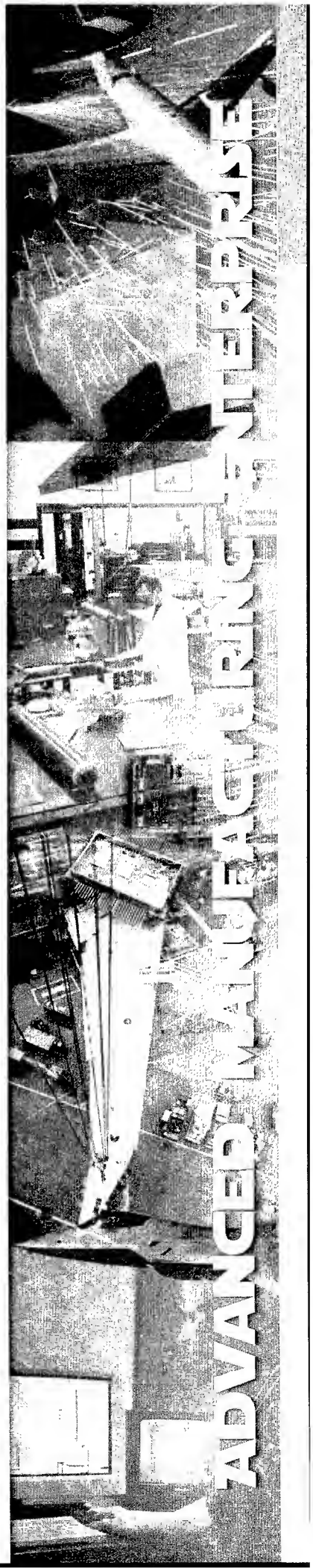
Obsolescence problems have become systemic and chronic in military as well as commercial systems. The Engineering Manufacturing Development (EMD) stage of some weapon systems can take five or more years. Production phases are stretched out over several more years and the actual mission life extends over decades. For example, the operational life of the B-52 is now projected to be over 90 years. Given that the typical product life cycles of most electronic components today are anywhere between 18 months to four years, most defense systems will have problems with obsolete equipment before fielding, and will certainly experience obsolescence during their service life. Appropriate design technologies and methods are critical to effectively address this problem. The goal of the program was to address obsolete electronics parts problems proactively in design, by developing tools that support a Pre-Planned Periodic Improvement strategy. That is, products must be designed from the beginning with the expectation that they will be reengineered several times over their life cycles. The objective then was to develop methods and tools that allow for very rapid and efficient design and redesign of electronics. TRW and its subcontractors addressed this by developing tools in the areas of behavioral synthesis and test vector generation. The Behavioral Product Reengineering Tool (BPR) was developed by Synopsys. A Design Verification Test Generation Tool was developed by the University of Cincinnati and was made available commercially by EDAptive Computing, Inc. The tool partially automated the test development process.

Benefits

Provided the ability to efficiently reengineer an existing design to replace an aircraft electronic part or a system; to incorporate new and/or modified functions to a product; and to design products from the beginning to minimize the impacts of obsolescence. By developing tools that support a pre-planned periodic improvement strategy, electronics products will be able to be designed and redesigned rapidly and efficiently, to support systems such as the B-52, whose operational life is projected to be over 90 years.

Manufacturing Technology USAF

For more information on this project, contact the Manufacturing Technology Division's Technical Information Center at (937) 256-0194. Refer to #1888.



Parts Obsolescence Management Tools

Contract Number: F33615-98-C-5147
Project Engineer: Theodore Finnessy
Contractor: i2 Technologies (formerly Aspect Development Incorporated)
Current Status: Active
Start Date: February 1999 End Date: December 2000

Objective

Determine the best practice for managing parts obsolescence from design and development through production, deployment and system support. In addition to cost trade study models, the development of predictive data elements are necessary for effective tradeoff study analysis. The lack of growth in the Department of Defense (DoD) budget for new programs presents a major challenge in sustaining and extending the service life of existing systems. Electronic parts obsolescence will have an even greater impact over time in older systems. Discontinued mature technology, shortened component and material life cycles, and military component supplier base reductions are three of the key factors that have forced the DoD and defense contractors to identify obsolescence management as a critical element within the system life cycle planning process.

Aspect Development has teamed with Raytheon Systems Company to develop and implement the following approach. First, all of the relevant obsolescence data and associated information must be collected and readily searchable and accessible. This will be accomplished by building upon Aspect's Explore™ and VIP Reference Databases. Second, tools must be obtained for analyzing the data and developing plans based on the results of the analysis. Third, the organization must respond to the plans and associated analysis. The key elements of the solution are best practice methods, data content, software tools, integration to older systems, and a process automation tool that tightly integrates these solution components. The solution will provide techniques such as graphical analysis and obsolescence reporting to enable more informed decision-making. This solution will provide the user a means to determine the most cost-effective engineering and manufacturing approach to the parts obsolescence management problem.

Benefits

Provides a low risk approach for the management of electronic parts obsolescence for both new and existing systems. It leverages commercially available tools and data content whenever possible. For example, Aspect licenses data from the Defense Evaluation Research Agency (DERA). The DERA life cycle data was selected because it was developed over many years, combining expertise in parts obsolescence, supplier information, and additional sources of obsolescence data. Additionally, the effort leverages integration to third party software and legacy systems whenever possible. To facilitate these integrations Aspect has formed partnerships with numerous suppliers. The combination of Aspect's experience in the component supplier management, combined with Raytheon's knowledge of military defense systems, logistics and obsolescence management, mitigates much of the risk associated with the development of this solution.

For more information on this project, contact the Manufacturing Technology Division's Technical Information Center at (937) 256-0194. Refer to #1890.

Predictive Activity-Based Cost Modeling Agent Network

Contract Number: F33615-99-C-5900
Project Engineer: Cliff Stogdill
Contractor: Cognition Corporation
SBIR Funded
Current Status: Active
Start Date: March 1999 End Date: October 2001

Objective

Update a central data repository/table with financial rates and factors that would be accessible by multiple cost estimating groups, such as detailed design Value Engineering Investigations (VEI), advanced design life cycle costs, or the Production Cost Model (PCM). Activity-based costing (ABC) has become popular among both financial and operational managers as a mechanism for understanding the sources of manufacturing related cost. ABC tracks costs based on the activities that generate them, and not on the traditional categories of labor, materials, overhead, etc. Effective use of ABC allows heightened visibility into the true cost drivers associated with a manufacturing enterprise. Currently, ABC is used to track costs as they occur and not to model or forecast them. With the advent of powerful, inexpensive computing and object oriented programming, the ability to model and simulate complex systems using collections of simple, autonomous software agents operating in parallel has become feasible.

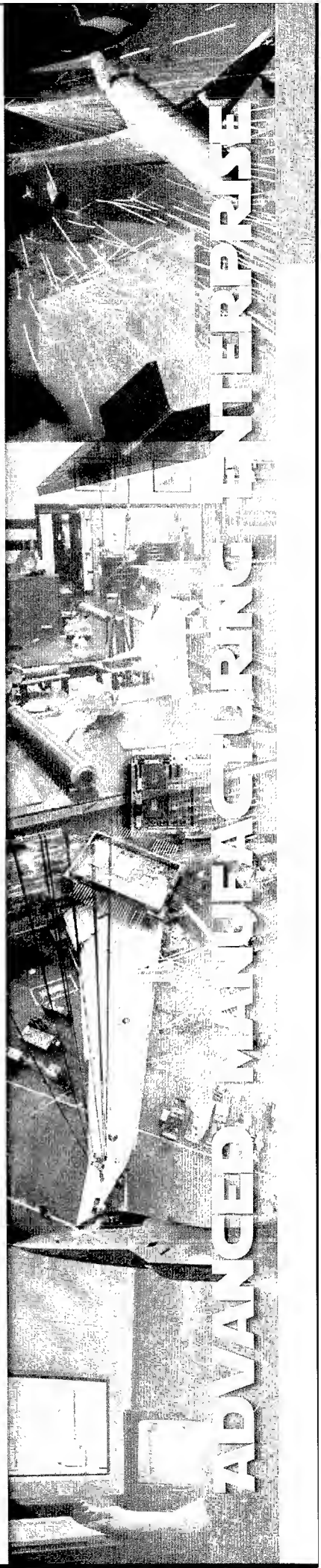
A six-month technical extension for this project was granted due to reorganization of Lockheed and Cognition's/Lockheed's subsequent inability to define a mutually acceptable project and demonstration. Cognition and Lockheed have since put together a project and demonstration that will use agents for prioritizing cost estimating for a reliability enhancement and reengineering program.

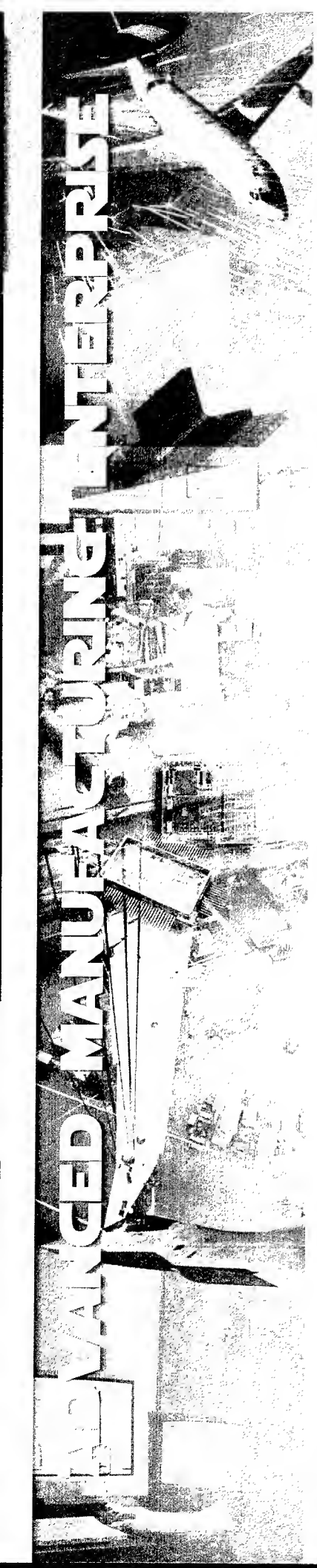
Benefits

Provide the ability to model and simulate complex systems, forecast costs within the context of an ABC accounting system, and allow manufacturers to more efficiently manage their resources and be more responsive in an ever changing market environment. Integration of the costing function has shown the capability to greatly reduce the time required to identify changes within the manufacturing process which effect cost and producibility, and to provide that information in a timely manner to the people who most need it.

Manufacturing Technology USAF

For more information on this project, contact the Manufacturing Technology Division's Technical Information Center at (937) 256-0194. Refer to #2563.





RASSP Approach to Legacy Electronics

Contract Number: F33615-98-C-5130
Project Engineer: Theodore Finnessy
Contractor: VP Technologies, Inc.
Current Status: Complete
Start Date: June 1998 End Date: November 2000

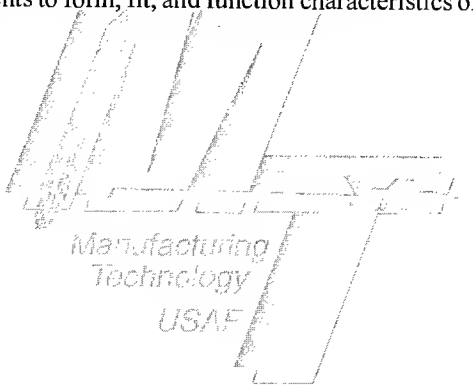
Objective

Develop an add-on module to an existing commercial product and adapt it for use by Air Force program offices and maintenance activities. The lack of growth in the Department of Defense (DoD) budget for new programs presents a major challenge in sustaining and extending the service life of existing systems. Electronic parts obsolescence will have an even greater impact over time in older systems. Discontinued mature technology, shortened component and material life cycles, and military component supplier base reductions are three of the key factors that have required the DoD and defense contractors identify obsolescence management as a critical element within the system life cycle planning process. This effort will identify and model a set of older components using an automated model generator from a library to be accessed by existing synthesis tools. Both combined and simulatable versions will be developed in VHDL (VHSIC Hardware Description Language) format, an industry standard for representation of electronic systems within commercial development tools.

Recent work has been on the VHDL code for an earlier avionics upgrade for the E-3 AWACS synchronizer performed under a previous contract. The code has been analyzed and repartitioned at a higher, functional level. This allows the existing hardware implementation to be recreated in the future with no dependence on current device technologies which would be unavailable in the future. Progress has also been made in the area of board-level reengineering. This emphasized the sustainment focus on card assembly instead of individual components. A method and tools for expressing and synthesizing the circuit boards are near completion.

Benefits

Trade studies can be performed on electronics upgrades for older systems without the need for physical prototypes, reducing the cost of aircraft electronics. The use of executable requirements, specifications and virtual prototypes will reduce the time required to design and field working prototype electronic systems. It also enables design captive in a form that promotes enhancements to form, fit, and function characteristics of all modification updates to existing systems.



For more information on this project, contact the Manufacturing Technology Division's Technical Information Center at (937) 256-0194. Refer to #1891.

Robust Design Computational System (RCDS)

Cooperative Agreement Number: F33615-96-2-5618
Project Engineer: Dr. Gene Himes
Contractor: Boeing Rocketdyne
DARPA Funded
Current Status: Complete
Start Date: February 1996 End Date: October 2000

Objective

Develop and demonstrate engineering tools and information integration capabilities that could be used to evaluate ten times as many design alternatives than is possible today in an attempt to improve several product characteristics such as reducing performance variability and increasing strength and reliability.

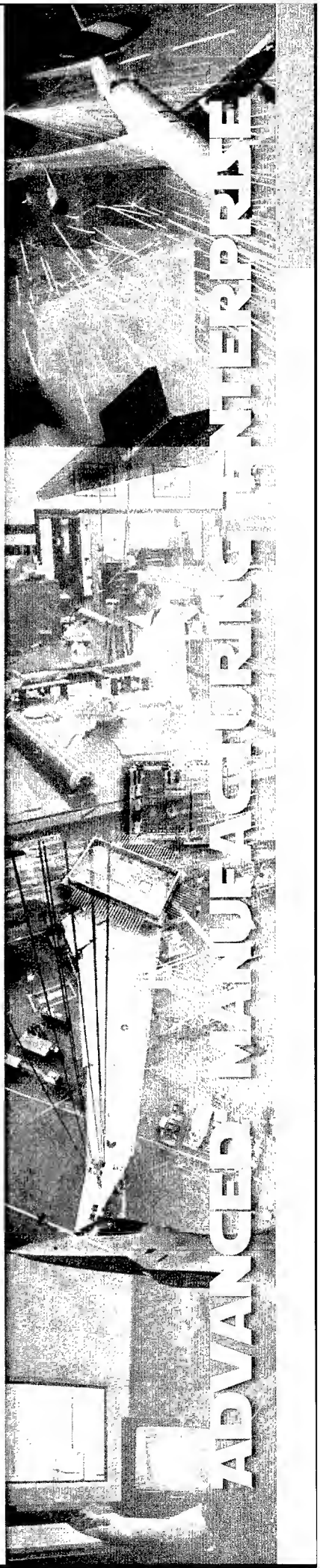
The approach for this program was to develop and demonstrate the next generation of design environments for complex systems as solicited by the Defense Advanced Research Projects Agency Manufacturing Automation and Design Engineering and Rapid Design Exploration and Optimization programs to achieve the following objectives:

- "...vision to create a highly flexible and responsive design environment that could be used to evaluate an order of magnitude more design alternatives than is possible today."
- "...optimize product characteristics such as quality, manufacturability, assemblability, and maintainability."
- "...to develop enabling technologies, tools, and infrastructure to provide cognitive support, during all phases of a design, to the engineer for vastly improving his/her ability to explore, track, store and analyze design alternatives."

Benefits

Develop tools and infrastructure to support the design engineer in rapidly exploring, generating, tracking and analyzing design alternatives allowing many more alternatives than previously possible. The design engineer will be able to begin with a parametric design representation, assemble a series of functional modules from multiple disciplines to simulate products and processes, efficiently evaluate the design options using distributed and parallel processing, invoke a variety of design sensitivity and optimization options, and effectively analyze the results to enable an informed design decision. Because RDCS allows the design engineer to consider the uncertainties and variabilities in the environment and manufactured hardware, the designer can develop more robust designs that are less sensitive to such variabilities.

For more information on this project, contact the Manufacturing Technology Division's Technical Information Center at (937) 256-0194. Refer to #1477.



Simulation Assessment Validation Environment

Contract Number: F33615-95-C-5538
Project Engineer: James Poindexter
Contractor: Lockheed Martin
JSF Funded
Current Status: Complete
Start Date: April 1995 End Date: September 2000

Objective

Implement, demonstrate, and validate integrated modeling and simulation (M&S) tools and methods used to assess the impacts of product/process decisions on the affordability of advanced strike warfare technology. Military aircraft manufacturing does not enjoy the traditional cost benefits of mass production because mass quantities are not usually required. Separating low cost from high volume requires new approaches to product and process design and technology maturation. Virtual Manufacturing (VM) supports this concept by applying modeling and simulation technology to prove out and select optimal new concepts. The Simulation Assessment Validation Environment (SAVE) program is a first step in realizing the near-term objectives common to VM and the Joint Strike Fighter (JSF) program.

The effort focused on initial implementation of VM strategically applied to specific real fighter and/or attack aircraft design and production affordability problems. The SAVE program was performed in two phases. The goal of Phase I demonstration was to take the user through a complete manufacturing scenario and communicate the functional capabilities of the developed tools. The Phase I demonstration validated the core VM capabilities, identified performance and business metrics against real production problems, and pointed to areas for continued refinement/enhancement to be accomplished during the second phase of the program. The Phase II effort targeted an ongoing weapon system's mechanical component or subassembly applications. Phase II culminated with a full demonstration of the developed VM capabilities applied to the targeted weapon system application.

The SAVE program software and development specifications are being transitioned to industry via the M&S standards community. Additionally, the first commercial software product based on SAVE, Cognition's Knowledge Center, was released in the fall of 1999.

Benefits

Achieve significant cost savings by providing integrated design teams with the capability to quickly perform "what-if" studies and accurately define a product's cost, schedule and risk early in the design process. A potential $1 billion, or 1-2 percent savings in life cycle cost are projected for the JSF.

Results from the three SAVE demonstrations include a cost savings of $114,000 on the next production lot of the F-16 in addition to a 1.6 percent reduction in manufacturing lead times (7.6hrs/480hrs) and a 21 percent reduction in number of design changes (from 110 to 87) measured from baseline.

For more information on this project, contact the Manufacturing Technology Division's Technical Information Center at (937) 256-0194. Refer to #1336.

Supply Chain Operational Excellence (SCOpE)

Cooperative Agreement Number: F33615-00-2-5901
Project Engineer: E. J. Kenworthy
Contractor: GenCorp Aerojet
Current Status: New Start
Start Date: March 2000 End Date: June 2004

Objective

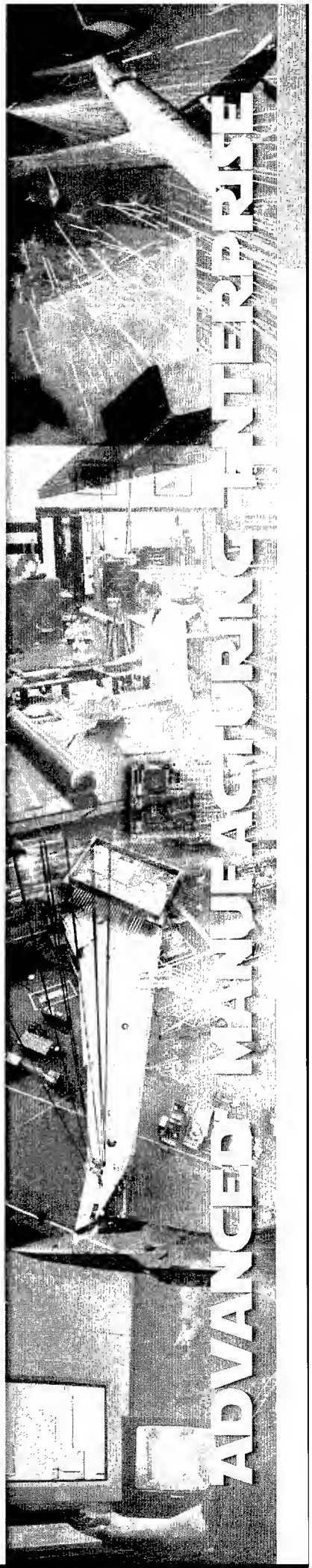
Collect data to sufficiently document a compelling business case for supplier improvement techniques. Metrics and measures may include quality improvement, cycle time reduction, and cost reduction. The contractor will identify key suppliers of critical components to several DoD systems. The contractor will provide analysis and develop a business case for the key components and determine which supplier development processes to implement with each supplier, based on customer requirements for the component. Metrics will based on the implementation at each supplier and the improvement technique used.

Benefits

Improved quality and reduced cycle time and production costs through the acquisition supply chain. This initiative addresses the importance of driving the Lean practices down to the subcontractors by training them in Lean tools so that they can make it part of their long-term culture.

Manufacturing Technology USAF

For more information on this project, contact the Manufacturing Technology Division's Technical Information Center at (937) 256-0194. Refer to #2821.



Systems Engineering Using Key Characteristics

Contract Number: F33615-98-C-5158
Project Engineer: Dr. Gene Himes
Contractor: Schwalb Consulting
SBIR Funded
Current Status: Complete
Start Date: September 1998 End Date: August 2000

Objective

Reduce the learning curve associated with the start of assembly by identifying and managing critical issues early in the product development cycle. The contractor developed an Internet-based tool to enable the identification, dissemination, and change management of key characteristics (KCs) throughout an enterprise. KC can be defined as product features, manufacturing process parameters, and assembly process issues that significantly affect product performance, function, and form. They are classified into three different types of engineering functions. Product key characteristics are product geometric features and material properties that have a significant impact on the product performance function and form at each product assembly level. Assembly process key characteristics are the features during each assembly stage of the product tool fixture or procedure that significantly affect the assembly process. Manufacturing process key characteristics are the manufacturing machine process parameters and/or work piece fixturing features for machine tools and equipment that significantly affect the realization of a product. KC when used in conjunction with the development of the work breakdown structures and the project planning processes could provide a vehicle to: significantly reduce the learning curve associated with the start of assembly by identifying the critical issues early in the product development cycle; and assess manufacturing cost trade-offs during product development by considering engineering issues, manufacturing process capability, assembly issues, and customer requirements. By identifying the critical product features up front, resources can be allocated to address them through multi-disciplinary teams.

The system uses an active constraint network architecture that is integrated with host applications such as computer assisted design/computer assisted manufacturing systems, process capability databases, and spreadsheets.

Benefits

Development of the tools and methods for systems engineering using KC reducing the learning curve associated with the start of assembly by identifying critical issues early in the product development cycle. The assessment of manufacturing cost trade-offs during product development can be better performed by considering engineering issues, manufacturing issues, and customer requirements.

For more information on this project, contact the Manufacturing Technology Division's Technical Information Center at (937) 256-0194. Refer to #1934.

Value Stream Mapping Applied to Product Development

Cooperative Agreement Number: F33615-99-2-5101
Project Engineer: E. J. Kenworthy
Contractor: Gencorp Aerojet
Current Status: Active
Start Date: September 1999 End Date: January 2003

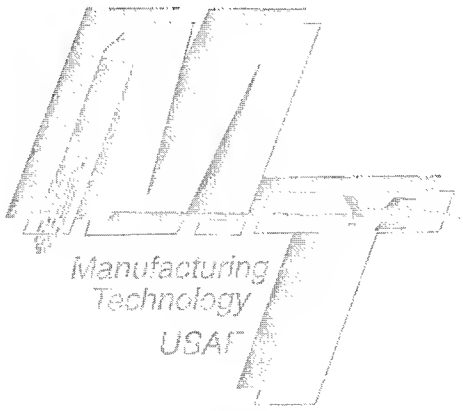
Objective

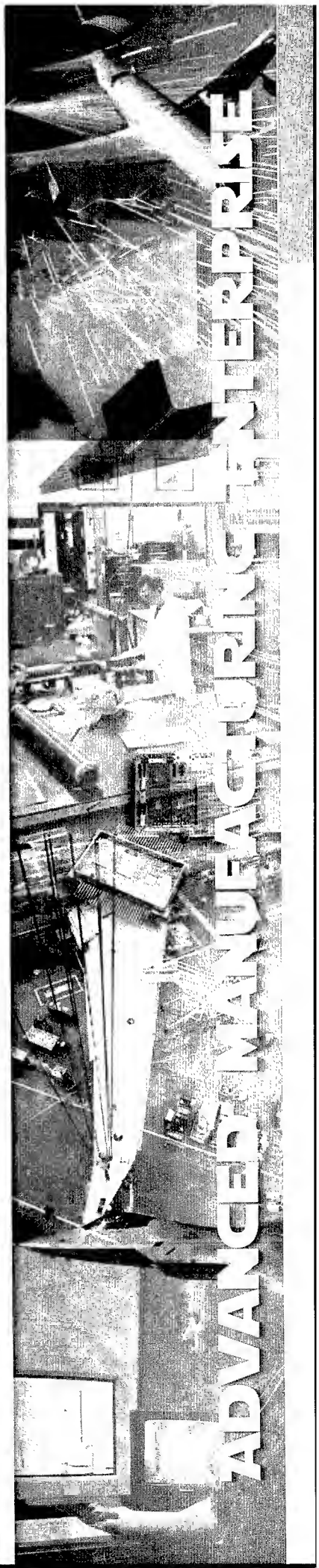
Develop a method for applying value stream mapping, used primarily in manufacturing, to product development, and to identify and eliminate non-value adding activity (waste) in the process. Transfer of a successful approach across the defense industrial base is the ultimate goal. The contractor will develop a tool or methodology for applying value stream mapping to the product development process. This will help identify in the development process non-value adding steps which can be eliminated.

Aerojet has performed research and benchmarking in the area of value stream analysis as applied to the product development process. They have researched and mapped their internal product development processes and have developed a software tool which will facilitate the pull of information through the development process. Several site visits have occurred, where information exchange helped to clarify areas for further work and collaboration with other companies. Presently, a risk information flow experiment is aimed at uncovering the process by which risk information flows through the product development cycle.

Benefits

Reduce cycle time and enable significant reductions in development and production costs within aerospace companies by implementing Lean principles and practices. As various programs in Aerojet and LAI member aerospace companies use the tools and methodology developed in this program, specific improvements in product development cycle time and costs will be measurably demonstrated and documented. Some of the risk assessment tools and risk information flow models developed in these programs will be used to identify and minimize program risks. The overall approach and methodology as developed in this project will be available for the aerospace and DoD community at large.





For more information on this project, contact the Manufacturing Technology Division's Technical Information Center at (937) 256-0194. Refer to #2618.

Weapon Systems Integrated Cost Model (WS-ICM): An Automated Methodology

Contract Number: F33615-99-C-5905
Project Engineer: David Judson
Contractor: Frontier Technology Incorporated
SBIR Funded
Current Status: Active
Start Date: April 1999 End Date: March 2001

Objective

Develop a Weapon Systems Integrated Cost Model (WS-ICM) framework of integrated cost architectures for modeling major cost categories of a weapon system by control level, within and among prime and subcontractors.

The Air Force Manufacturing Technology Division, in conjunction with the F-22 System Program Office, is interested in the establishment of a methodology that supports weapon systems production management considering cost as an independent variable throughout the total life cycle. Each contractor will create a conceptual WS-ICM framework design during detailed work on the selected specific cost category (i.e., the life-cycle Cost Estimating Model (CEM) or the Operational and Support Model (OSM)). The WS-ICM has come from a strong customer pull (System Program Offices and contractors) who need tools to help them make accurate affordability decisions in the new acquisition environment. The market is large scale manufacturing operation programs.

A Production Cost Module (PCM) and Operation and Support Model (OSM) model are currently being developed for demonstration and will be shared for integration with the contractor. Frontier Technology's (FTI) efforts on the WS-ICM/CEM development task during the performance period include the review and refinement of the methodology developed during Phase I. The Technical Review Board meeting, participation at conferences, other briefings and discussions continues to surface issues related to the WS-ICM tool, and using it as a baseline. In an Air Force pilot site effort, FTI provided cost estimates for use in the Mobile Approach Control System (MACS) Analysis of Alternatives (AOA) for the Air Force and Air National Guard requirements.

This Small Business Innovation Research Phase II project will refine the affordability methodology, data and models prototyped and demonstrated in Phase I for cost estimating. The Cost Estimating Model (CEM) will be capable of operating as a stand-alone capability or as a functional component of the Weapon System-Integrated Cost Model (WS-ICM).

Benefits

Developed a weapon system cost estimating model. When used in the Mobile Approach Control System Analysis of Alternatives Acquisition, it will establish and cost quantify a complete set of high quality requirements, saving several million dollars. The Cost Estimating Model demonstrated a 35 percent savings, operating as a stand alone capability and up to 90 percent time reduction as the life cycle cost estimating component of the Weapon System Integrated Cost Model.

For more information on this project, contact the Manufacturing Technology Division's Technical Information Center at (937) 256-0194. Refer to #2385.

Weapon Systems Integrated Cost Model (WS-ICM) - Production Cost Model (PCM)

Contract Number: F33615-98-C-5137
Project Engineer: David Judson
Contractor: Wallace & Company
SBIR Funded
Current Status: Complete
Start Date: May 1998 End Date: May 2000

Objective

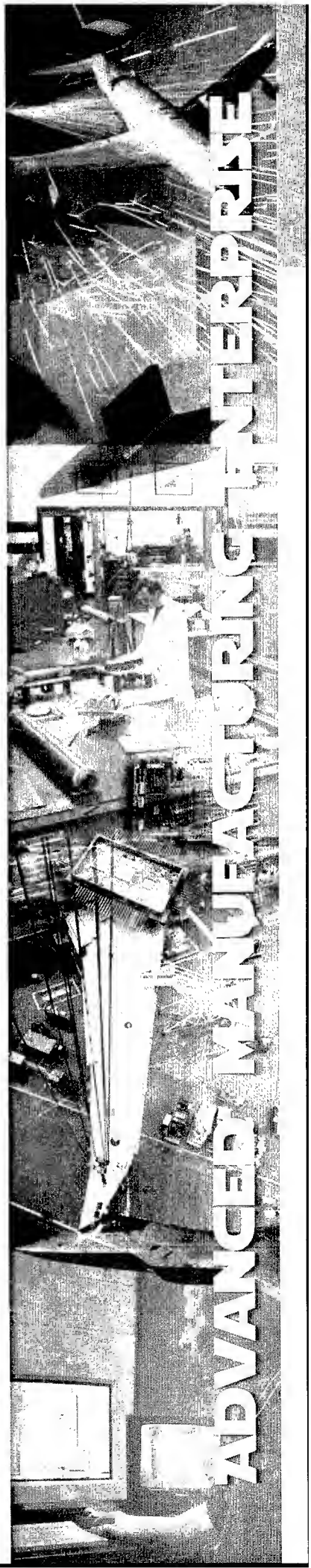
Build and validate the generic product cost model (PCM). The Manufacturing Technology Division aggressively pursues advances in manufacturing technology which have broad applicability to the affordability and performance of Air Force systems. The focus of this general topic is to allow opportunities for major breakthroughs in the areas of composites processing and fabrication; electronics processing and fabrication; metals processing and fabrication; advanced industrial practices; and manufacturing and engineering systems. New processing techniques, variability reduction tools, affordability improvements, manufacturing simulation and modeling, are a few examples of the types of proposals that are desired. The emphasis is on innovation, the ability to achieve major advances, and defense/ commercial applicability. The PCM was installed in a beta site, and on a production program, after validation by the contractor. The PCM provides management with a decision support tool to determine the affordability of on-going production and a cost control for manufacturing in a predictive approach, rather than reactive.

The PCM provides both identifiable savings in software development and the quality of information made available for management decision making. This project created a generic computer-based production cost model to support systems program offices in managing cost of the weapon system using the new acquisition reform initiatives. The PCM integrates with the Weapon Systems-Integrated Cost Model. The PCM supports the information requirement of costs as an independent variable, including aggressive cost goals, trade-off analyses, incentive measurements and contains a flexible reporting capability. The tool is currently in use in the Wallace cost consulting business as part of the required validation. Wallace customers will be trained on the PCM tool upon validation completion.

Benefits

Provided the ability to model the cost of a weapon system production program while avoiding up to 75 percent of the time and cost normally required to build a program-specific, detailed production cost model. Major weapon systems programs, modifications and updates, which used an earlier version of PCM, experienced recurring cost savings in the 15-25 percent range. With the added features of PCM, even more recurring costs can be eliminated earlier in the program, compounding the impact of the savings.

For more information on this project, contact the Manufacturing Technology Division's Technical Information Center at (937) 256-0194. Refer to #1673.



Web-Based Collaborative Warfighter Cost Per Fighting Hour

Contract Number: F33615-00-C-5903
Project Engineer: David Judson, MLMS
Contractor: Frontier Technology Incorporated
SBIR Funded
Current Status: New Start
Start Date: May 2000 End Date: May 2002

Objective

Create the Fighting Power by Fighting Hour (FPFH) analytical tool and extend the Weapon System-Integrated Cost Model (WS-ICM) providing an integrated life cycle cost flying hour estimating and cost analysis capability. It will use the FTI Integrated Cost Estimating (ICE) tools and an underlying data base technology to make the data required by the cost modeling methods available throughout the entire life cycle for analyses.

A web-based cross-platform design environment, in a performance-based marketplace will focus on the early phases of acquisition to facilitate profound changes in the product design processes. There will be growth in participants due to the integrated process and product development methods that are fundamental to these changes. These participants are from various disciplines within an organization and up and down the multi-tiered supply chain, all of who will have the opportunity to converge and engage each other on problems and solutions. The requirements for reduction in processing power, accuracy and currency of data, voracity, and a global 24-hour-per-day design environment will be without precedence, and indeed, a paradigm shift in need of work-flow scheduling and dependency-tracking given the undeterred access by all who wish to participate.

This project takes an excellent approach to cost management, and brings strong techniques to creating a solution for cost analysis, trades and estimates based on metrics, comparisons, standards, inline insertions and actual collected data. This is an F-22 and Joint Strike Fighter-sponsored affordability project.

The evolving tools are also being used by the Air Force Cost Analysis Agency as a front end to Air Force Total Ownership Cost database for the Sustainment Initiative Analysis and for cost estimating seven Advanced Technology Demonstrator programs. Additionally, the evolving Weapon Systems-Integrated Cost Model/Fighting Power Fighting Hour prototype is supported by user beta sites.

Benefits

Enables rapid analysis, forecasting of improvement concepts, updates and modifications for weapon systems including return on investment, investment analysis, best value, and operations and support. Current users are experiencing up to 90 percent savings in time and a reduction in the number of people required to provide an effective cost-analysis capability.

For more information on this project, contact the Manufacturing Technology Division's Technical Information Center at (937) 256-0194. Refer to #2851.

Accelerated Production Effects on Theater Campaigns

Contract Number: GS-35F-0014J
Project Engineer: Michael Baker
Contractor: Decision Sciences Incorporated
Current Status: New Start
Start Date: December 2000 End Date: March 2001

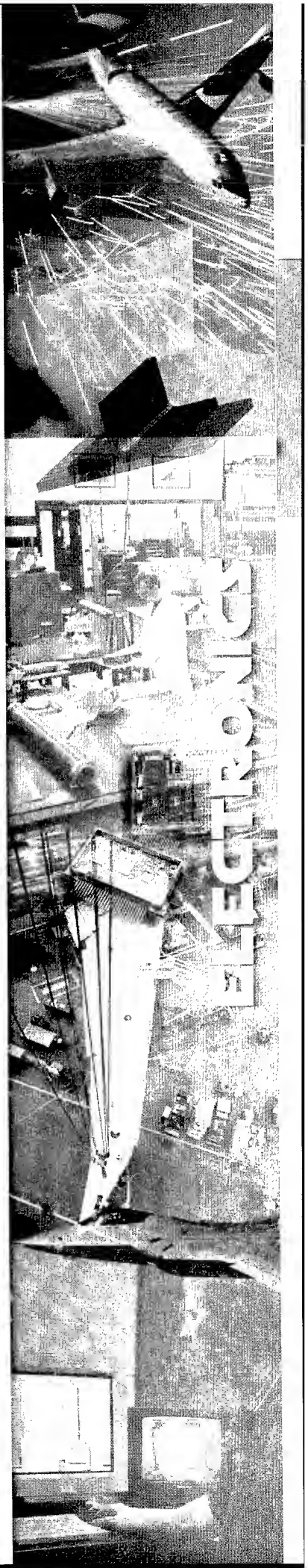
Objective

Support future warfighting commitment munitions requirements. The latest DoD readiness report follows several earlier editions that sounded similar alarms about declining readiness to undertake war contingencies. The last report observed that the ongoing peacekeeping commitments in the Balkans and elsewhere degrade U.S. ability to fight one or more major theater wars in the future. The Chairman of the Joint Chiefs of Staff, Secretary of Defense, and the chiefs of the four military services compiled a plan called Joint Vision 2020. Within the context of this joint vision, the DoD and the Air Force are re-emphasizing the requirement for "full spectrum dominance," ranging from major force-on-force engagements to small-scale contingencies, and the variety of other crises for which US forces are in high demand.

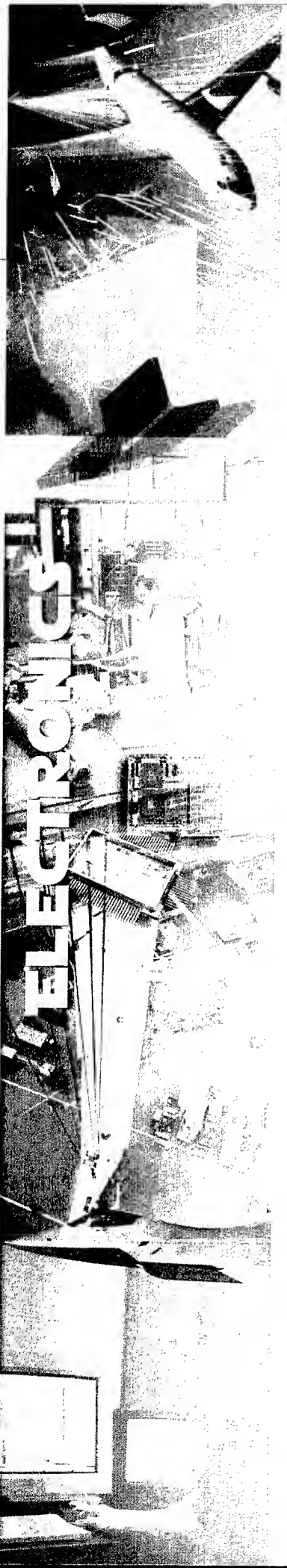
By improving the overall understanding and visibility of the munitions gap, a larger degree of fidelity will be added to the existing conflict planning due to surge analysis. Planning can be measured in terms of millions of dollars saved over conventional procurement strategy. This will allow better support of the warfighter. This project will result in the capability to relate information based upon Air Force mission areas with Strategies-To-Tasks. This information will be related to specific theater conflict scenarios and munitions types. The web-based system will be capable of linking web-based surge modeling to the conflict scenarios and will provide seamless information in near real-time to user agencies/groups.

Benefits

Provide the ability to support future warfighting commitments with sufficient munitions to meet the demands of readiness requirements.



For more information on this project, contact the Manufacturing Technology Division's Technical Information Center at (937) 256-0194. Refer to #2936.



Acoustic Wave Inspection of SOI Substrates

Contract Number: F33615-98-C-5111
Project Engineer: Ron Bing
Contractor: IBIS Technology Corporation
SBIR Funded
Current Status: Complete
Start Date: February 1998 End Date: August 2000

Objective

Develop technology for detecting and quantifying Separation by Implanting of Oxygen (SIMOX) wafer defects and establishing a correlation between Impulsive Stimulated Thermal Scattering (ISTS) and device radiation hardness and yields. State-of-the-art wafer processing is only as good as the quality of the starting substrate materials. As technology has greatly reduced the size of active components and allowed the integration of vast amounts of circuitry on a chip, the starting material quality has become a major variable in determining the final yield of a product. Not only is it important to have high wafer surface quality, it is equally important to have substrate crystal uniformity (i.e., defect free beyond the depth of the junctions of the active devices).

The contractor implemented shorter wavelength laser exitation to enhance Impulsive Stimulated Thermal Scattering (ISTS) detection capability. The contractor investigated methods of automating multiple point testing on radiation-tolerant SOI substrates and the generation of statistical yield data. A minimum of five wafers per lot for 20 production lots was examined for nondestructive and automated analysis of silicon defect density and gauge of material quality for gate oxide integrity. The contractor established correlation of the effect of silicon dislocations on device yield and gate oxide integrity.

This was a Phase II Small Business Innovation Research project. Program activities included analysis of the optical coefficients of SIMOX wafers with spectroscopic ellipsometry, as planned in the previous report, and establishment of the subcontract program with Honeywell for the analysis of the impact of the defect density in SIMOX substrates on the device's yield.

Benefits

Provided improved radiation hard wafers for use in higher performance sensors and other military electronics systems. This effort resulted in a method to measure the silicon and boron oxide layers in SIMOX wafers and the correlation between layer thickness and defect density. These two pieces will lead to a method for evaluating and characterizing SIMOX wafers that can lead to better process control in the manufacture of radiation hard electronic components.

For more information on this project, contact the Manufacturing Technology Division's Technical Information Center at (937) 256-0194. Refer to #2288.

Air Combat Command Operation Flight Process (ACCOFP) Analysis

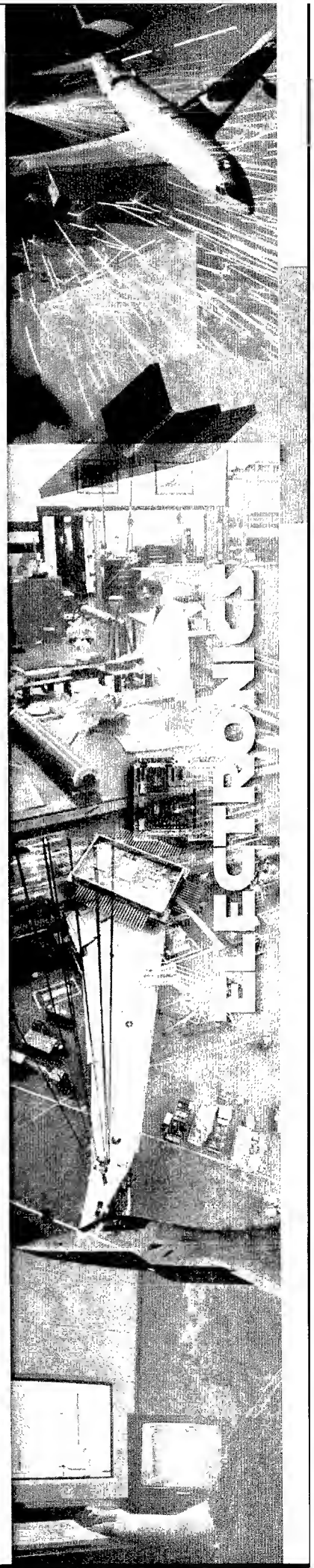
Contract Number: GS-35F-0014J
Project Engineer: Michael Baker
Contractor: Decision Sciences Incorporated
Current Status: New Start
Start Date: September 2000 End Date: September 2001

Objective

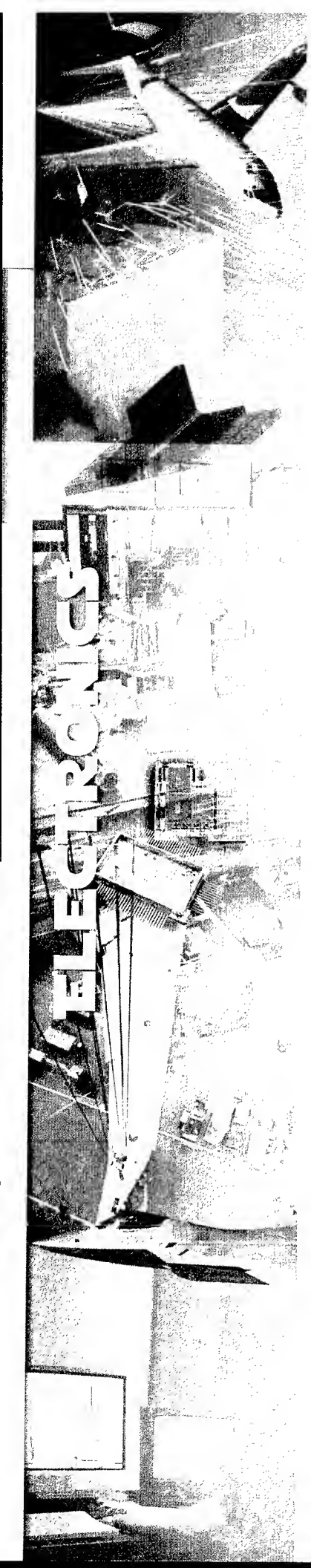
Provide Air Combat Command (ACC) a vision into status of current and future warfighting capability by providing near real-time/network-based information to illuminate and solve potential schedule delays and slippage. ACC lacks adequate insight into operational flight process (OFP) decision making and requires real-time/web-based information flow. ACC needs a forecast capability as to the availability of suite and block changes for aircraft that would permit proactive decisions (tactical and economic). Primary emphasis will be placed on the ability to communicate information within the Design Structured Matrix (DSM) to appropriate locations. Consideration will be provided to the aircraft System Program Office (SPO) to allow for web-based and/or web-enabled features of updating and delivering critical information. Maximum use of the existing DSM infrastructure within the ACC Operational Flight Process Analysis is envisioned. Lean concepts and web capability for data communication shall be implemented in a non-intrusive format.

Benefits

Improve operational readiness of ACC aircraft by providing visibility into the status of component readiness of aircraft suite/block modification status. This will make ACC better able to plan scheduling of fleet aircraft, minimize out of service time of the aircraft, and make informed decisions regarding cost, schedule and performance. The ACC Operational Flight Process Analysis will be capable of communication of information between the SPO and ACC. When complete, a relevant solution should provide: (a) illumination of potential schedule delays and their associated causes, (b) a mechanism for proactively mitigating the impacts of schedule delays, and (c) insight into avionics/OFP operational decision making time compress from the current process to the new web-based processes.



For more information on this project, contact the Manufacturing Technology Division's Technical Information Center at (937) 256-0194. Refer to #2935.



Application of Commercial Parts Obsolescence Management (CPOM)

Cooperative Agreement Number: F33615-99-2-5500
Project Engineer: Anthony Bumbalough
Contractor: Northrop Grumman Corporation
Current Status: Active
Start Date: June 1999 End Date: November 2003

Objective

Effectively use Commercial Off The Shelf (COTS) parts in long lived military systems by integrating obsolescence management tools with an improved design/procurement/ manufacturing/data management process and environment. The prime objective of the program is to document the cost avoidance resulting from the implementation of obsolescence management tools, reliability tools, corporate initiative tools and lean corporate best practices. A pilot line which produces products common to multiple systems such as Common Radar Modules will be used for demonstrating the cost effectiveness of using the tools and practices. Metrics will be developed and data continually collected to assess the cost effectiveness of the policies and the utility of the tools when compared to the baseline. This approach will complement major corporate thrusts to leverage commercial parts and apply them to electronic modules for a number of radar systems. The engineering toolset framework is known as Parts Obsolescence Engineering Toolset (POET). The commercialization of POET will help infuse the results of the pilot project into the defense industrial base. The POET framework will allow product information to be managed as files in industry standard formats which are related to one another with simple data structures. Integration of these tools with the emerging obsolescence management tools into a design to cost environment that allows the customer and the design team to establish mission, performance, and cost targets should create a very powerful design process. COTS parts, commercial IP, and new complex systems models will be handled by the inclusion of Systems Level Description Language tools into the POET.

The approach is to be based heavily on commercially available software which can easily be disseminated into the defense supplier base. This project will establish a baseline for the evaluation of obsolescence management tools and best design practices through the collection of data on a legacy program. The Obsolescence Management Pilot Program (OMPP) will implement new tools and best practices, and collect comparison data on a development pilot line that employs a high degree of COTS and Application Specific Integrated Circuits technology. This effort will address key technical issues which are necessary for improving the use of commercial microcircuit, radio frequency and mixed signal technologies in defense systems. Issues to be addressed include the application of a Physics of Failure approach to the selection, qualification, assembly, and reliability prediction of COTS circuitry. Particular attention will be paid to the capture of design requirements and Intellectual Property (IP) for retargeting of designs as complex devices become obsolete. High pin out devices and the problems that they pose will be addressed as well.

Benefits

Develop a low cost, low complexity mechanism for data integration, which will facilitate the integration of reusable designs and design processes into electronic modules for radar systems.

For more information on this project, contact the Manufacturing Technology Division's Technical Information Center at (937) 256-0194. Refer to #2589.

Combat Survivor Evader Locator (CSEL) Module Improvement Process

Contract Number: F33615-99-C-5508
Project Engineer: Charles Wagner
Contractor: Alliant Techsystems Incorporated
Current Status: Complete
Start Date: October 1999 End Date: August 2000

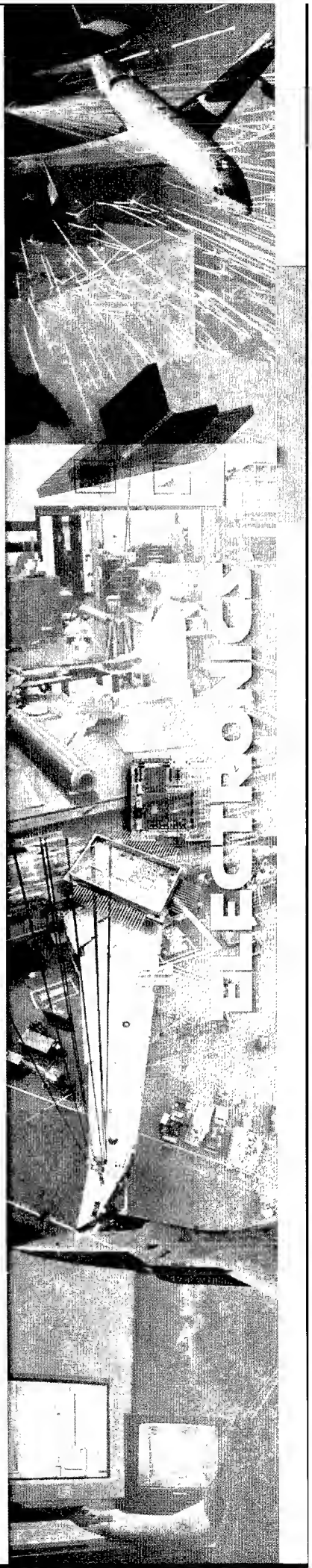
Objective

Provide a tamper-resistant Global Positioning Satellite (GPS) /Selective Availability Anti-Spoofing Module (SAASM) manufacturing process coating capability for the CSEL Hand Held Radio being developed by Boeing.

This program will initially baseline the current approach to protecting the SAASM device for later comparison purposes to the improved process. The contractor will conduct preliminary coating experiments and define preliminary process parameters to define the trade space for various coating techniques that might be used. The program will develop a detailed manufacturing process development plan to support the baseline SAASM. The contractor will fabricate, conduct acceptance test and deliver five (5) prototype CSEL SAASM Modules (CSGM) for integration into CSEL hand-held radio.

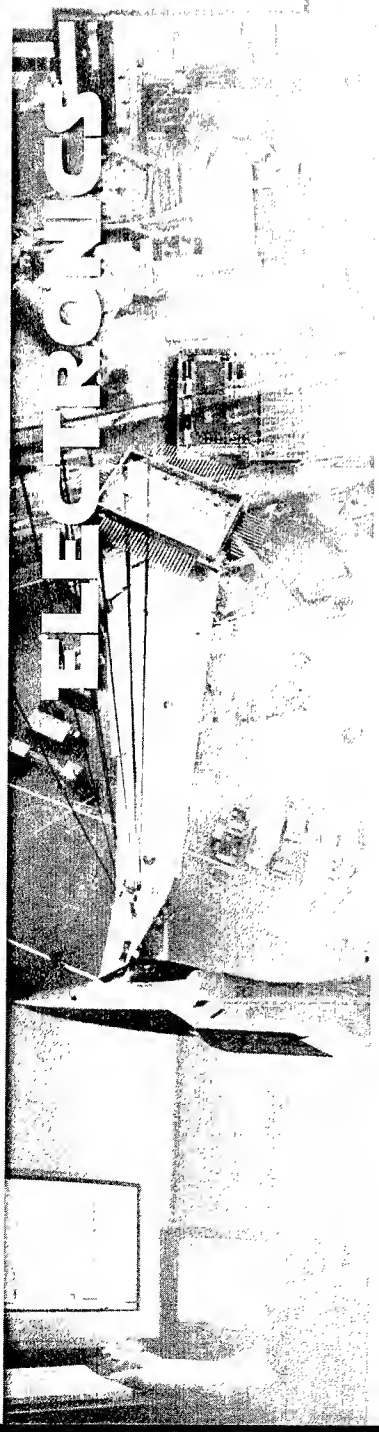
Benefits

Provide a high yield, low cost National Security Agency-approved tamper resistant coating process for electronic circuit card assemblies. The CSEL hand-held radio program will be the first fielded system to benefit from this effort.



Manufacturing Technology USAF

For more information on this project, contact the Manufacturing Technology Division's Technical Information Center at (937) 256-0194. Refer to #2615.



ELECTRONICS

Conformable Multichip Assembly Technology

Contract Number: F33615-98-C-5149
Project Engineer: Charles Wagner
Contractor: EPIC Technologies Incorporated
SBIR Funded
Current Status: Active
Start Date: September 1998 End Date: November 2000

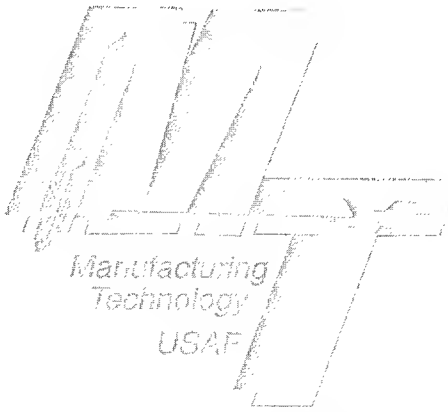
Objective

Develop a flexible, high-density, chip-scale packaging/assembly technology capable of being bent or twisted to conform to irregular shapes or volume that might be encountered in a space constrained military or commercial electronic system. Two specific near term objectives for this effort are to: establish a robust manufacturing process for the fabrication of reliable Chip Scale Packages and high performance, high density, multilayer flex circuits and assemblies; and demonstrate the technology for space (or volume) constrained electronic systems' prototypes that are representative of current military products with similar constraints.

EPIC has fabricated two different chip scale packages that will be used as benchmark test vehicles. Both versions have different monitoring characteristics embedded into their layout to capture thermal, shock, and other environmental test results.

Benefits

Provide high density, chip-scale packaging for military electronic systems.



For more information on this project, contact the Manufacturing Technology Division's Technical Information Center at (937) 256-0194. Refer to #2043.

Flexible Space Vehicle Production Line

Cooperative Agreement Number: F33615-99-2-5505
Project Engineer: Ron Bing
Contractor: TRW Incorporated
Current Status: Active
Start Date: June 1999 End Date: September 2002

Objective

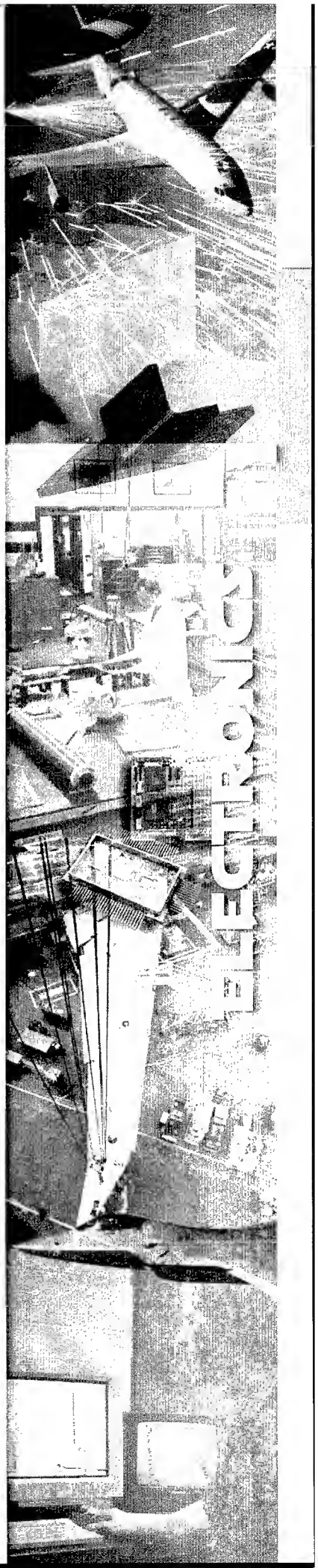
Develop a new spacecraft architecture that will integrate diverse satellite payloads with a modular, mission-adaptable spacecraft configuration and to ensure that the lowest cost designs are compatible with lean manufacturing capability. A flexible space vehicle production line also needs to be established that emulates a volume production line that accommodates a wide range of bus and payload assemblies. Materials and manufacturing technologies need to be qualified that enhance competitiveness and transfer these technologies to adjacent and commercial markets.

TRW will establish a flexible, multiple mission lean production line to integrate diverse payloads with a standard modular spacecraft architecture for any mission or orbit. In Phase I they will develop a new spacecraft architecture, a lean manufacturing infrastructure, and the materials and manufacturing technology. Phase II will consist of a pilot program to demonstrate these developments.

For the Spacecraft Architecture, the hardware architecture has been defined and trade studies have been performed to determine the new standard chassis/panel design. In the area of Materials and Manufacturing Technologies, trade studies have been performed to determine cost and performance benefits of composites and aluminum and the components baseline has been benchmarked. Trade studies have been performed to establish optimum design for component fabrication.

Benefits

Provide a 50 percent reduction in costs and a 50 percent reduction in cycle time in the manufacture of electronics for space vehicles.



Manufacturing Technology USAF

For more information on this project, contact the Manufacturing Technology Division's Technical Information Center at (937) 256-0194. Refer to #2379.

Gap Analysis of Munitions Effectiveness (GAME)

Contract Number: GS-35F-0014J
Project Engineer: Michael Baker
Contractor: Decision Sciences Incorporated
Current Status: New Start
Start Date: December 2000 End Date: March 2001

Objective

Make it possible to visualize potential munitions gaps in future warfighting capability.

The Secretary of Defense and senior military officials have revised the vision for the armed forces and come up with a new joint vision, which reflects fresh thinking on the types of contingencies for which the US must be prepared. It considers the role of allied coalitions and the fast-paced technological change that has been a hallmark of the post-Cold War period. Within the context of this joint vision, the DoD and the Air Force are re-emphasizing the requirement for "full spectrum dominance", ranging from major force-on-force engagements to small-scale contingencies, and the variety of other crises for which US forces are in high demand. In addition, the DoD and the Air Force will continue with its commitment to being able to fight and win two major theatre wars and is giving greater significance to peacekeeping and operations other than war.

The proving ground for tomorrow's strategies, tactics, and investment decisions is played out in joint wargaming environments. Within this realm, senior DoD leadership is supported, first-hand, by the confluence of information technology, decision support systems, and today's procurement decisions on the outcome of future conflict scenarios. Through the use of advanced industrial base methodologies, the GAME initiative will bring together these components and make it possible to visualize potential munitions gap in future warfighting capability.

Benefits

Ensure adequate munitions are available to meet the warfighters' needs. Provide advanced information technology applications and methods for determining potential delinquencies in munitions that may impact future warfighting capability. Contractor supplied briefings will be given during planning events and will include information on surge analyses, macro analysis of weapons draw-down, and impact of weapons shortage in terms of opportunity cost in near real time. By improving the understanding and visibility into the munitions gap, the improvements will allow warfighting planning to be based upon realistic expectations of munitions availability. Planning for peacetime acquisition of munitions will be improved and a possible 10 to 20 percent reduction in munitions acquisition costs will be achieved.

For more information on this project, contact the Manufacturing Technology Division's Technical Information Center at (937) 256-0194. Refer to #2938.

Infrared Focal Plane Array/Flexible Manufacturing

Contract Number: F33615-93-C-4320
Project Engineer: Virginia McMillan
Contractor: Texas Instruments Inc.
DARPA Funded
Current Status: Complete
Start Date: September 1993 End Date: November 1999

Objective

Develop and demonstrate the materials, detector processing, sensor electronics, packaging, cryogenics and assembly technology to permit flexible manufacturing of a wide range of array configurations, both staring and scanning. System application categories include: missile seekers, space surveillance, target acquisition sights, search and track systems, man-portable acquisition sights, and threat warning systems. The Infrared Focal Plane Array/ Flexible Manufacturing (IRFPA/FM) program is not intended to incrementally improve existing technology, rather, the goal was to demonstrate new concepts in the flexible manufacture of focal plane arrays and focal plane array modules with associated electronics and cryogenics.

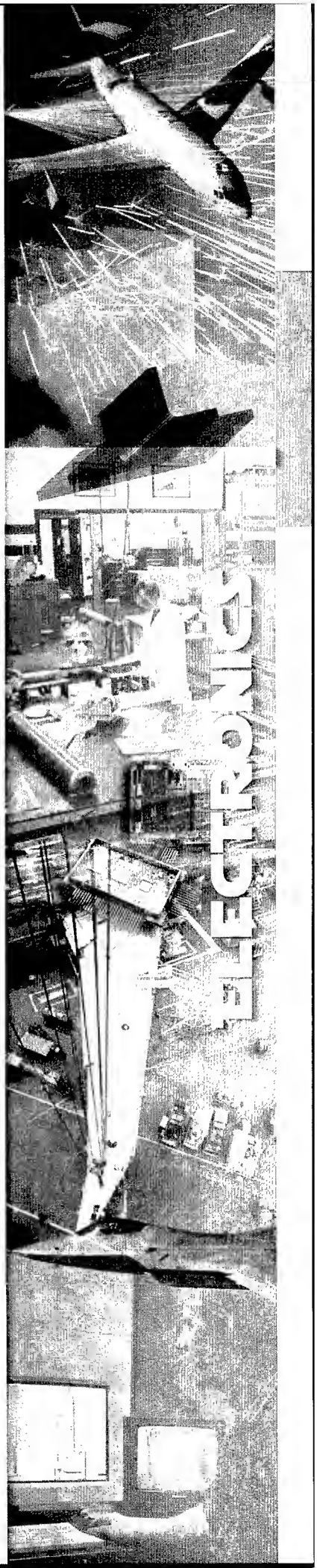
The Electronics Manufacturing Process Improvement (EMPI) program is a multi-year program to enhance the producibility of electronic components and assemblies through enhanced process control using quality technologies. The primary objective is to promote the application and implementation of statistical techniques for the improvement of electronic manufacturing processes that support the Department of Defense electronics industry sector. Innovative applications of process controls to improve the quality of materials, components, processes, tests, and assemblies used in the manufacture of Air Force systems are being pursued. Nine contracts were awarded which satisfied the objectives of this program. The contractors implemented the improvements gained as a result of the effort of the EMPI programs. They also provided a means for transferring the technology that produced those improvements to others within the same industry. The resulting benefits to the Air Force, the contractor, and the industry are in the following areas: improved product reliability, improved process controls, reduced product costs, or reduced cycle time. The individual programs relied heavily on the team process and used such techniques as Statistical Process Control (SPC), Design of Experiments (Taguchi and classical methods), Quality Function Deployment, Variability Reduction, cause and effect analysis, and flowcharting.

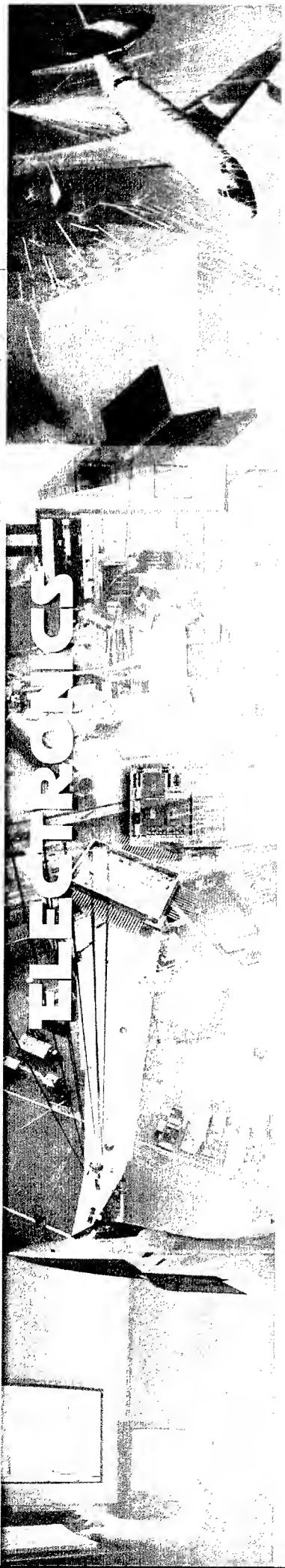
This program developed and integrated modular processing equipment for mercury cadmium telluride detector array fabrication, established a sensor-based computer integrated manufacturing control system, generated smart design tools, implemented manufacturing procedures to reduce the fabrication cycle time of cryogenic readout integrated circuits, developed automated design and assembly capability of infrared focal plane array dewar packages, and performed a baseline, interim, and final production run for staring and scanning infrared focal plane array modules to demonstrate the developed FM capability.

Benefits

Provided a reproducible, affordable, and flexible production capability for IRFPA modules for Infrared Search and Track missile, munition, and spacecraft applications.

For more information on this project, contact the Manufacturing Technology Division's Technical Information Center at (937) 256-0194. Refer to #1173.





Light Detection and Ranging (LIDAR) Wind Sensor Manufacturability

Contract Number: F33615-97-C-5145
Project Engineer: Walter Spaulding
Contractor: Coherent Technologies Incorporated
Current Status: Complete
Start Date: August 1997 End Date: August 2000

Objective

Enable the transition of an eye-safe LIDAR wind sensor transceiver to a robust, production ready design which can be employed in numerous applications; to leverage the science and technology Integrated Product and Process Development (IPPD) training program; to demonstrate the application of Design for Manufacturing (DFM) and Rapid Prototyping in the transition of the LIDAR system to production; and to address affordability early in the lifetime of the system by application of IPPD principles. Recent advances in solid-state, diode pumped, coherent lasers which operate at eye-safe wavelengths have made it practical to consider affordable remote wind measurement devices to be installed on military aircraft, airport runways and eventually commercial aircraft. Applications for airborne Light Detection and Ranging (LIDAR) wind sensors include systems which provide a wind corrected ballistic aimpoint for guns, systems which provide a wind corrected release point for unguided bombs and missiles, systems which provide wind field measurements for improved air-drop accuracy, systems which measure local air data parameters for avionics and flight control systems, systems which detect wind shear, and systems which measure high altitude winds aloft, aircraft wakes, and clear air turbulence, among other applications. The development of a Doppler LIDAR sensor has enabled the demonstration of these applications and proven the feasibility and advantages of airborne wind field measurement. While these laser sensors are mature enough to consider for production systems, the production of current designs remains labor intensive and requires a high amount of precision hand alignment and tuning.

A reference transceiver was fabricated and assembled incorporating the manufacturing improvements to date. The modular control electronics have been designed and fabricated and incorporate built-in test functions that should serve to help diagnose and troubleshoot LIDAR problems in the field as well as speed the assembly of the LIDAR system.

Benefits

Provided an eyesafe LIDAR wind sensor transceiver for use on military aircraft, for correcting the ballistic aimpoint for guns, and for correcting the release point for unguided bombs and missiles. This project enabled multiple applications to be satisfied by a common family of components. It reduced or eliminated the amount of precision hand alignment and touch labor required in the production and maintenance of a LIDAR transceiver. The effort focused on manufacturability, commonality of components, and affordability/sustainment.

For more information on this project, contact the Manufacturing Technology Division's Technical Information Center at (937) 256-0194. Refer to #1498.

Manufacturing Technology for Affordable Millimeter Wave Units

Cooperative Agreement Number: F33615-99-2-5504
Project Engineer: Ron Bing
Contractor: TRW Incorporated
Current Status: Active
Start Date: June 1999 End Date: December 2002

Objective

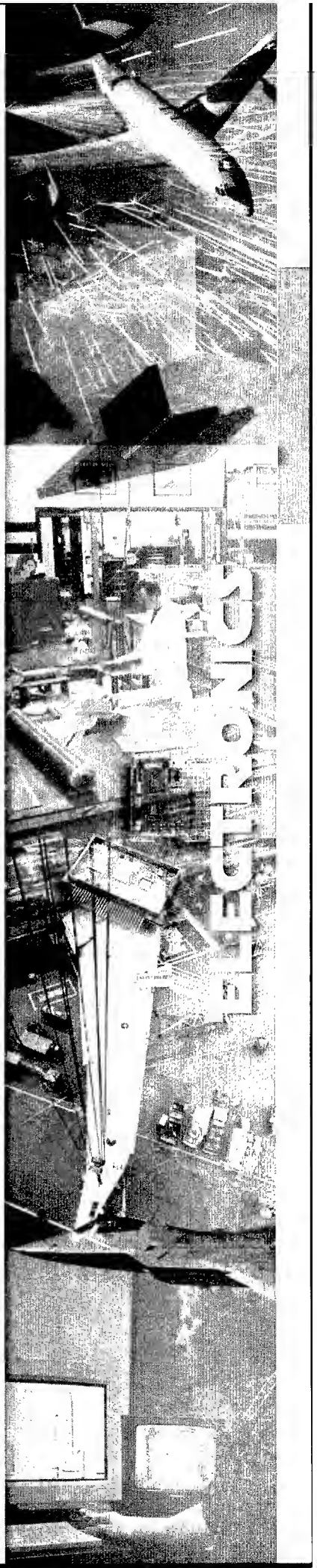
Establish the feasibility of low cost commercialized spacecraft electronics production, quantify the benefits via pilot production of key digital elements, develop commercialized production guidelines, and transfer the technology to the Air Force and commercial spacecraft production programs.

TRW will develop metrics for board and module cost; select a board and module approach with the least costs; develop an automatic tuning method; design modules and boards; and conduct production demo against the metrics.

The contractor: designed and built a pathfinder module and low observable board; investigated ball grid array technology; simulated and optimized all needed structures on beryllium oxide (BeO) for mm-waves; designed new BeO test structure for coax, waveguide, via fences, and chip transitions; tested BeO transitions and transmission lines; started definition of the down converter module and phase shifter module; investigated radio frequency board material; designed and started fabrication of test structure.

Benefits

Provide low cost spacecraft electronics for a variety of military and commercial applications. This program will result in an 80 percent reduction in tune and test costs, a 90 percent reduction in board assembly costs, and a 30 percent reduction in module/board parts costs.



Manufacturing Technology USAF

For more information on this project, contact the Manufacturing Technology Division's Technical Information Center at (937) 256-0194. Refer to #2380.

Parts Obsolescence and Reliability Prediction

Cooperative Agreement Number: F33615-98-2-5167
Project Engineer: Brandon Lovett
Contractor: Motorola Incorporated
Current Status: Active
Start Date: February 1999 End Date: November 2001

Objective

Develop a comprehensive approach to system reliability prediction for electronic components and board level systems in military operating environments. Existing reliability models today have been typically developed for a single, isolated component and have not looked at the system level interactions. These models have typically not been extended to the more stringent military application. To accurately accomplish system level life prediction and estimate component reliability as a part of a credible parts obsolescence plan, there is a need for an integrated toolset that will model the interplay between multiple failure mechanisms and validate the models with field data from commercial products.

This effort will first examine existing failure prediction methods, analyze and upgrade existing software tools developed under previous contract efforts, and develop methods to compare reliability prediction with field return data collected on similar components in commercial products. A software package will be developed that integrates multiple reliability models, implements a trained neural network, incorporates a material database including field-return data, and incorporates a graphics user interface. This software tool will be used for predicting total system reliability of both component and board level products in a variety of operating conditions.

Motorola has successfully completed their first four milestones. The following work tasks have started. Field return data collection is underway. The sources for the field return data have been identified. Identification and classification of failure mechanisms is underway. Reliability model benchmarking and enhancement has began. Motorola is currently researching different types of neural networks to incorporate the reliability models and field return data. Motorola has purchased a neural network modeler to efficiently build a neural network.

This effort will build on existing single-mechanism and physics of failure reliability models to develop a software tool that integrates several diverse reliability models and correlates predicted methods with a commercial field return database. This reliability prediction software tool can then be used for selection and qualification of parts obsolescence management.

Benefits

Develop a software tool that can be used for reliable prediction of failure in military electronics systems, resulting in safer aircraft with less downtime.

For more information on this project, contact the Manufacturing Technology Division's Technical Information Center at (937) 256-0194. Refer to #2461.

Parts Obsolescence Management Technology Transition (POMTT)

Cooperative Agreement Number: F33615-99-2-5502
Project Engineer: Brandon Lovett
Contractor: Lockheed Martin Corporation
Current Status: Active
Start Date: September 1999 End Date: December 2000

Objective

Address parts obsolescence challenges and use three cooperating company divisions to conduct multiple validation efforts as part of the pilot program demonstration. Parts obsolescence issues are escalating, elevating costs and adversely impacting program schedules. Current tools and procedures cannot provide the program manager with the best value business and technical solutions to mitigate obsolescence risk. The effort will create an in-depth plan to transfer the knowledge gained from this program throughout the corporation via a unique Engineering Process Improvement (EPI) corporate structure. Technologies and processes developed under the Application of Commercially Manufactured Electronics (ACME) part of the Electronics Parts Obsolescence Initiative will be integrated with the tools and procedures established to yield flexible design alternatives for low cost solutions. This pilot demonstration program will encompass a wide envelope of system operating environments and represent programs in various states of maturity from development to production. This strategy will provide a robust business and technical verification of business and technical performance of the tools and procedures established under the initiative.

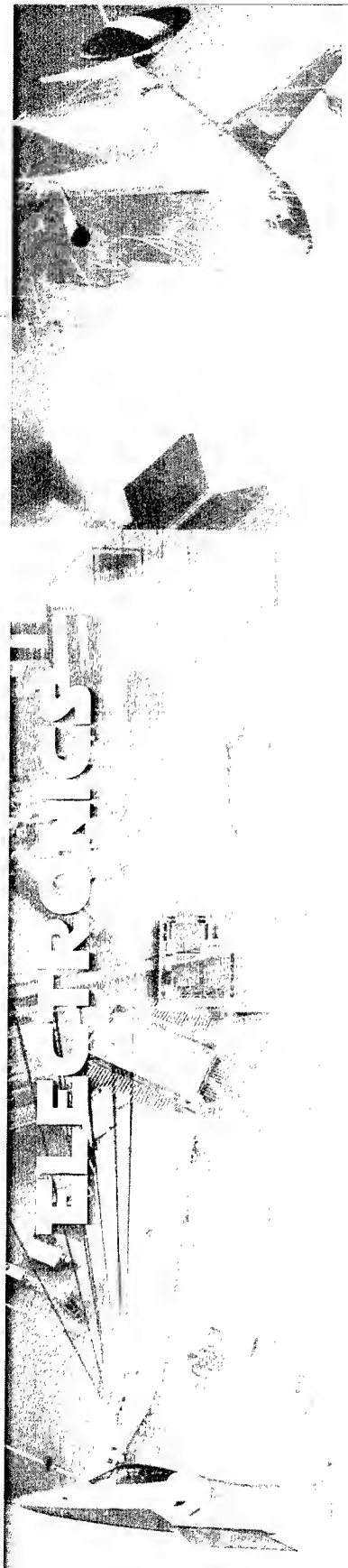
This project will: provide technical assistance and guidance to the Parts Obsolescence Management Tools (POMT) suppliers in the development of products; integrate commercial design strategies including the use of commercial components such as Application Specific Integrated Circuits (ASICs) into the tool capabilities; evaluate the POMTs through pilot demonstrations; and validate their cost effectiveness using actual business cases.

Lockheed Martin has awarded subcontracts and interdivisional work transfer authorizations. The collection of baseline data for cost evaluations is underway. Evaluations of the Electronic Parts Obsolescence Initiative tools have begun. A list of possible pilot demonstrations is expected by September 2001.

Benefits

Improve tools and procedures for obsolescence management resulting in lower life cycle operating costs and provide flexible design strategies to mitigate obsolescence risk for a best-value solution. This will result in more reliable weapon systems with less downtime.

For more information on this project, contact the Manufacturing Technology Division's Technical Information Center at (937) 256-0194. Refer to #2289.



Physics of Failure Approach to Sustainable Electronic Systems (PASES)

Cooperative Agreement Number: F33615-99-2-5503
Project Engineer: Brandon Lovett
Contractor: University of Maryland
Current Status: Active
Start Date: June 1999 End Date: April 2003

Objective

Demonstrate a transferable, proactive methodology that reduces maintenance and life cycle costs of electronics for fielded Department of Defense systems by enhancing reliability. The PASES program focuses on lower life cycle sustainment costs for defense systems through a cradle-to-grave physics of failure (PoF) approach. This approach is up-front and proactive to achieve system reliability, manufacturability, technology and parts risk management, and affordability. In this effort, Computer Aided Life-Cycle Engineering Electronic Products and Systems Center at the University of Maryland proposes to develop a PoF methodology for cycle time reduction and failure prevention, then assess the economic impact of this methodology. Price Systems LLC, a subcontractor, will be involved in the cost modeling effort. A prototype implementation will be performed, and a full scale implementation plan will be defined. The program will consist of three phases, Methodology and Implementation, Prototype Implementation and Verification, and Methodology Critique and Refinement.

Benefits

Develop tools to provide a proactive approach to electronic parts obsolescence mitigation, which focus on a physics of failure approach. This will result in safer, more reliable weapon systems, with less downtime. The program will look at reliability prediction, manufacturability, and cost as a part of risk management.

For more information on this project, contact the Manufacturing Technology Division's Technical Information Center at (937) 256-0194. Refer to #2590.

Radar Common Module Insertion (RCMI)

Cooperative Agreement Number: F33615-99-2-5506
Project Engineer: Brandon Lovett
Contractor: Northrop Grumman Corporation
Current Status: Active
Start Date: September 1999 End Date: September 2003

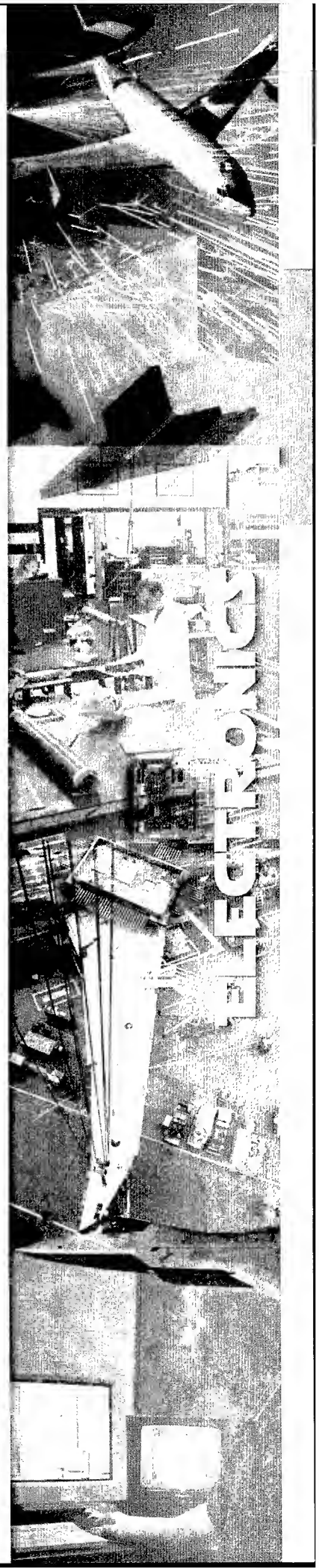
Objective

Demonstrate a method for optimizing reliability and life cycle cost of electronics. The Radar Common Module Insertion (RCMI) program will do this through redesign of modules for fire control radar. The methodology will include modeling and simulation for failure mode identification, commercial-military integration in parts selection, software reuse, hardware commonality, and alternative design and maintenance concepts. RCMI will demonstrate, through this radar module redesign, a methodology that emphasizes reliability and life cycle cost considerations early in design. This program will demonstrate methodologies, tools, and procedures for reducing life cycle costs on a version of the APG-68 radar system.

Work is underway and on schedule. Employees are undergoing training for the various tools being implemented in this program. Spray cooling investigations have also begun.

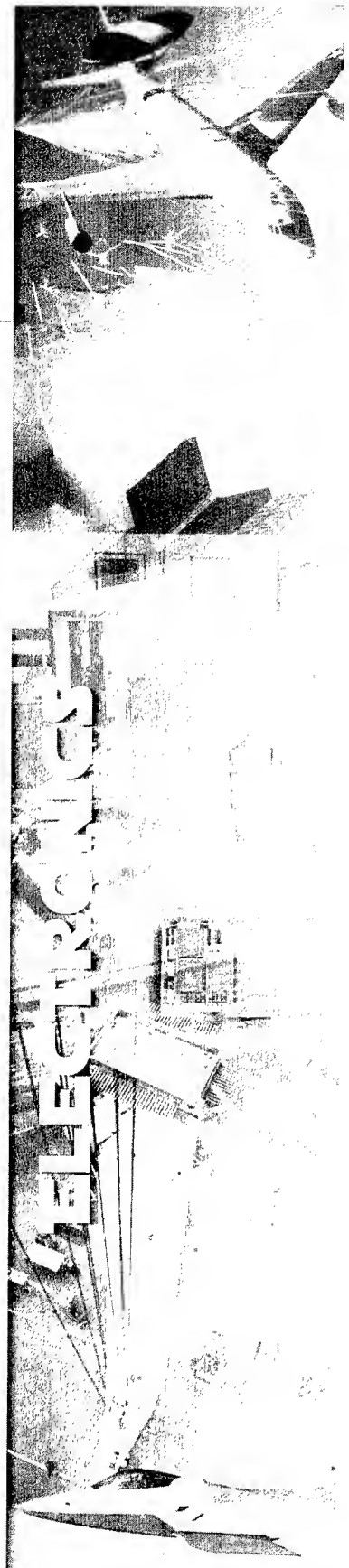
Benefits

Reduced sustainment and operations and support costs for legacy radar systems used on current Air Force weapon systems. Benefits should include improved Mean-Time-Between-Failure, reliability growth, and extended time between maintenance.



Manufacturing Technology USAF

For more information on this project, contact the Manufacturing Technology Division's Technical Information Center at (937) 256-0194. Refer to #2649.



Reliability Prediction Validation and Commercial Foundry

Cooperative Agreement Number: F33615-99-2-5501
Project Engineer: Anthony Bumbalough
Contractor: The Boeing Company
Current Status: Active
Start Date: April 1999 End Date: March 2003

Objective

Facilitate the use of commercially produced parts for military applications. This effort consists of two activities: enhancing and validating durability and reliability modeling tools with commercial field failure data; and establishing an Application Specific Integrated Circuit (ASIC) flexible design capability to provide the opportunity to consolidate military purchases from commercial semiconductor foundries.

The first segment of this program consists of enhancing and validating software tools which can predict and assess the reliability of various Commercial Off The Shelf parts. The predictions will be based on their manufacturing processes and the operational environment to which the parts will be exposed. To achieve this, the effort will include: performing a survey to determine commonly used component types; enhancing the recipient's existing Fatigue Synthesis for Avionics Programs model with sensitivity, vibration, and electrical power dissipation analysis capabilities; gathering field failure data; identifying failure modes; performing sensitivity analyses to determine parameters that are critical to reliability; and verifying the validity of model predictions with field failure data and with laboratory experiments under controlled conditions. The second segment of this program consists of establishing a design capability for mixed signal ASICs that uses a flexible design. This design will be foundry-independent, enabling commercial semiconductor foundries to produce military-grade parts. It will also allow for the retrofit capability of legacy systems where parts and processes used for their production have become obsolete. This second segment will be accomplished by: selecting ASIC foundries; establishing a process host; retargeting the Standard Cell Design Library; developing the Macro Cell Generator; updating design tools; generating a pathfinder design; fabricating and testing the design; updating the design library; and repeating the process at a second foundry to confirm the foundry independence of the process.

Boeing has begun research for field return data. They have been visiting program offices and have recently forged a relationship (a nondisclosure agreement with a company which produces processors for several U.S. military systems). The ASIC design center is staffing up and beginning to work relationships with the other participating companies of the Electronic Parts Obsolescence Initiative.

Benefits

Produce functional designs for military electronic parts that can be fabricated at multiple commercial foundries, reducing the cost while maintaining the quality of weapon systems.

For more information on this project, contact the Manufacturing Technology Division's Technical Information Center at (937) 256-0194. Refer to #2384.

Warrior Support Activity (WSA)

Contract Number: GS-35F-0014J
Project Engineer: Michael Baker
Contractor: Decision Sciences Incorporated
Current Status: New Start
Start Date: September 2000 End Date: September 2001

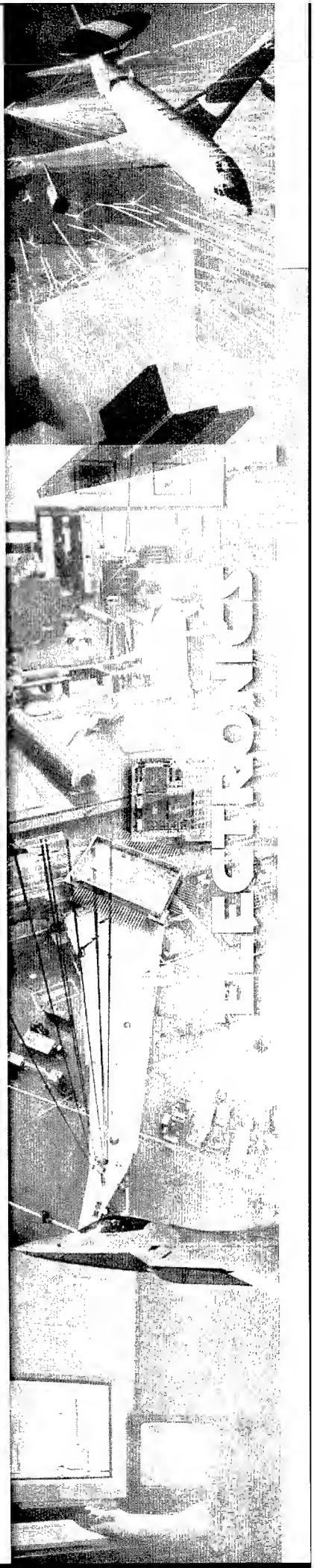
Objective

Provide decision support for both on-going weapon procurements as well as new initiatives, and provide greater insight into the infrastructure of the industrial base that supports the procurement of these systems. The operational environment of tomorrow's warfighter is directly dependent on the decisions that are made in today's acquisition community. The opportunity to impact this environment is limited due to a shrinking industrial base, fewer suppliers, a trend towards the extension of weapon system life expectancy, and reduced funding levels for the procurement of warfighter assets. Within this new environment, it is clear that the Air Force must proactively plan for the advancement in warfighter capability in the area of munitions. The mission of the Air Armament Center (AAC) is to design, develop, and procure missile and munitions systems for our war-time fleet of aircraft. The Armament Product Director has developed an initiative called the Warrior Support Activity (WSA). Activities within the WSA will be focused on providing the warfighter with advanced technology for better managing smart and brilliant missile and munitions systems – from cradle to grave and beyond.

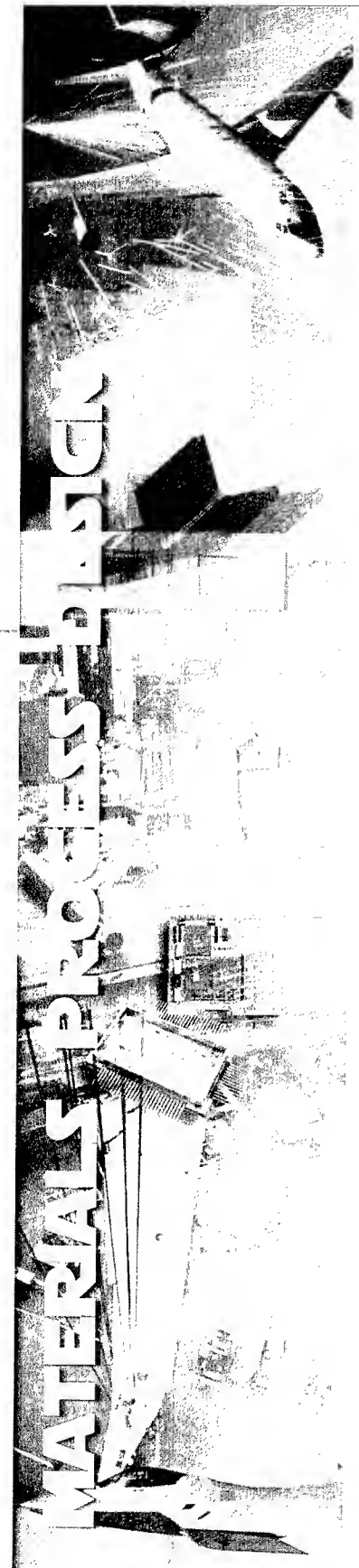
Planning and procurement of a selected munitions system with surge analyses will be demonstrated. WSA will be further linked to current and planned inventory levels in order to provide pertinent information whereby decisions can be formulated for procurement and design strategies. USAF munitions surge analysis will encompass applicable systems identified by the AAC. The existing surge analysis concept will incorporate the capability to input data relating to a munitions system production directly from the component suppliers of the integrating contractor.

Benefits

Provide the ability to support future warfighting commitments with sufficient munitions to meet the demands of future readiness requirements.



For more information on this project, contact the Manufacturing Technology Division's Technical Information Center at (937) 256-0194. Refer to #2937.



Advanced Adaptive Optical Coating Process Technologies

Contract Number: F33615-00-C-5522
Project Engineer: Dr. John Maguire and Steve Fairchild
Contractor: Protein Express Incorporated
SBIR Funded
Current Status: New Start/Complete
Start Date: March 2000 End Date: August 2000

Objective

Design adaptively controlled optical coating processes to either infer or enable direct measurements of optical properties. The development and use of scanning probe microscopes (SPM) has provided researchers with breathtaking images of materials down to atomic length scales. This project will investigate a novel approach to combining two such SPMs, an Evanescent Optical Microscope (EOM) and a Scanning Tunneling Microscope (STM), into one sensor device. This EOM/STM would allow for the first time the simultaneous scanning of both the optical and the electrical properties of a sample (at the same exact location and the same time) with submicron spatial resolution. This device will be capable of providing scanned images showing the variation of surface optical properties, inter-layer and film-to-substrate coupling, the local photoluminescence and/or the surface topology of the sample.

The contractor developed a sensor for deposition characterization and control of thin film coatings; an analytical tool for the characterization of adaptive optic components and coatings; and an analytical tool for analyses of thin film materials and devices including semiconductors, metals, organic materials, and biological samples.

Benefits

Enable the direct measurements of, and the subsequent control of, the optical properties of in-situ films in the deposition of optical coatings. Until now, the capability of producing this level of simultaneous, unified information into the detailed optical and electrical properties of films and materials did not exist.

For more information on this project, contact the Manufacturing Technology Division's Technical Information Center at (937) 256-0194. Refer to #2830.

Automated Data Acquisition for In-Situ Material Process Modeling

Contract Number: F33615-97-C-5841
Project Engineer: Dr. John Busbee
Contractor: InfoScribe Technologies Limited
SBIR Funded
Current Status: Active
Start Date: May 1997 End Date: February 2001

Objective

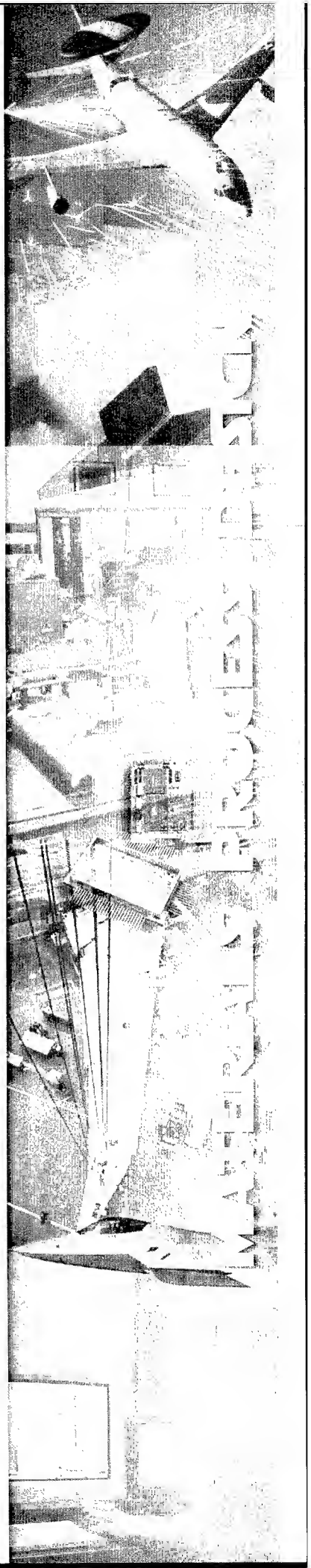
Design the data acquisition and process control system and maximize real-time capabilities. This will improve the quality and lower the costs of processing advanced thin film materials. With respect to Air Force needs, this system will address deficiencies in current data collection methods for eddy-current inspections in the retirement for cause program for engines at Tinker AFB, OK.

Materials research is progressing at a rate faster than the processing technology and researchers are capable of observing, with information far exceeding what a human can digest. This requires that the processing equipment be used to its complete potential to augment the researcher in adapting to ever-changing processing conditions. The first step is to encode the current understanding of how each input of the process affects the outputs. Once completed, a control system model will be able to construct a model from empirical data and identify differences, and based upon defined material qualities. This project will: implement a design for the InfoScribe data acquisition system; implement modeling methods to support off-line and on-line data exploration via simulation; assess the process modeling and control system through instrumentation and application to a number of processes; create dynamic linked libraries to interface InfoScribe to the eddy-current inspection system; install a system at Tinker to collect inspection data; and investigate the use of intelligent agents for data-mining in collected data.

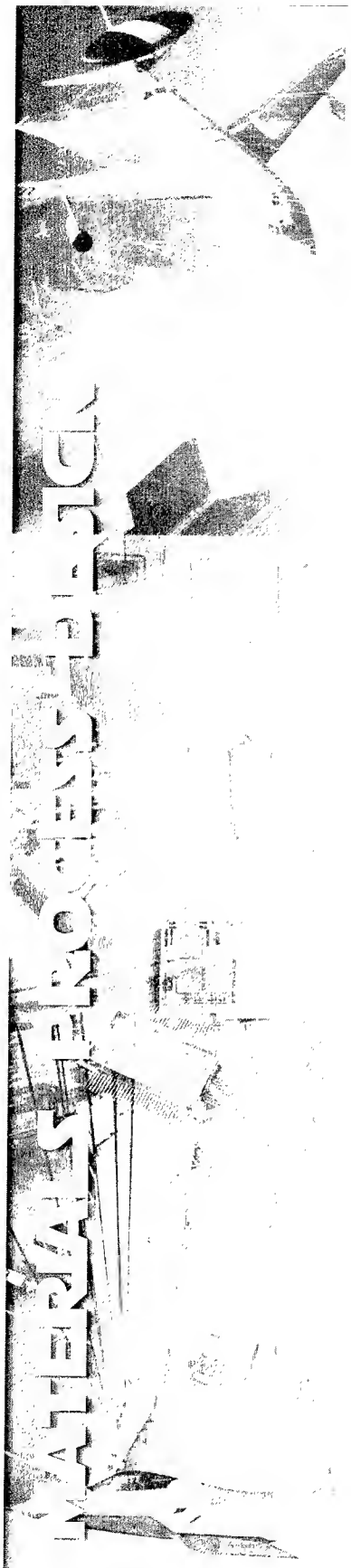
Current effort is implementing secure user access control via web and high bandwidth data streaming interface. Inter-process messaging and task preemption were implemented along with shared graphical user interfaces. All clients have file searching and data parsing access to all InfoScribe data files on all mounted storage volumes. The interface was tested with LabView and Windows NT dynamic linked libraries on remote computing platforms. These interfaces support bi-directional data acquisition and process control across computing platforms. An InfoScribe server has been installed on one inspection station in the depot at Tinker AFB.

Benefits

"Virtual," timely inspection of parts in order to determine the cause of failure, avoiding grounding of the fleet, as done in the past with older, time-consuming inspection techniques. Commercially, the developed technology would have broad appeal in improving the quality and lowering the costs of processing advanced thin film materials ranging from electro-optical materials for semiconductors, superconductors, thin-film displays, etc., to advanced multi-layer coatings for commercial aircraft and engine systems. All of these commercial applications are constrained by affordability considerations similar to those faced by the DoD.



For more information on this project, contact the Manufacturing Technology Division's Technical Information Center at (937) 256-0194. Refer to #1703.



Development of An Advanced Laser-Based Processing Method

Contract Number: F33615-00-C-5521
Project Engineer: Steven Fairchild
Contractor: Mound Laser & Photonics Center
SBIR Funded
Current Status: New Start/Complete
Start Date: March 2000 End Date: August 2000

Objective

Development of lengths of superconducting tape on the order of one kilometer and this proposal addresses some of the key issues to the attainment of this goal. The largest film of such material is one meter long. Increasing the scale to a length of even 15 meters necessitates a better understanding of factors controlling the film superconductivity performance and the development of process monitoring and control techniques to enable controlling the film quality. More importantly, the ability to detect defects followed by the subsequent removal or healing of these sections is essential to the ability to process fault free large lengths of superconducting films. Copper-oxide superconducting ceramics with superconducting temperature exceeding the boiling point of liquid nitrogen (77°K) were first synthesized in 1986. The development of such innovative materials focused on two main issues: increasing the superconductivity temperature and processing films of the superconducting material with large dimensions.

It has been demonstrated that the use of a low power AO Q-switched Nd:YAG laser source can be used to modify the surface of a substrate material for subsequent deposition of a high temperature superconductor (HTS) film of Yba2Cu3O7-x (YBCO). YBCO films have been deposited on the surface-modified substrates via the pulsed laser deposition (PLD) process. Preliminary results indicate that the properties of the HTS were significantly improved. Several nickel substrates have been evaluated, but the technique can be applied to any material. The initial results are encouraging but will require additional development, as well as process monitoring and control, to develop a commercially viable system. This proposal addresses the process development criteria necessary to establish a laser surface modification system suitable for commercialization.

Benefits

Developed an advanced adaptive processing technology to enhance YBCO film properties and produce the long lengths of these materials required for space-based applications. This project demonstrated the feasibility of a laser-based surface modification technique to improve substrate properties for subsequent deposition of YBCO high temperature superconducting films. The effect of the surface modification will be quantified by measurement of the superconducting properties and by micro-Raman spectroscopy. The approach taken to develop this processing technology has been carefully crafted to readily incorporate process monitoring and control techniques thus ensuring a high quality, uniform substrate prior to YBCO deposition.

For more information on this project, contact the Manufacturing Technology Division's Technical Information Center at (937) 256-0194. Refer to #2831.

Interactive Simulation System for Design of Multi-Stage Manufacturing Processes

Contract Number: F33615-98-C-5114
Project Engineer: Dr. Garth Frazier
Contractor: Austral Engineering
SBIR Funded
Current Status: Active
Start Date: April 1998 End Date: August 2001

Objective

Develop an extensible computer platform for the integrated simulation-and-optimization-based design of multiple stage manufacturing processes (forging, machining, heat treatments, extrusion, etc.). Materials insertion applications and spare components for aging aircraft systems offer tremendous opportunity to introduce innovative methods, processes and material systems to reduce weight and costs while improving wear, temperature and strength performance. The need is for material process design methods which consider alternative processing which lead to significant reduction in design and fabrication times. Of particular interest is the design and fabrication of precision tooling to enable materials substitution or replacement components that are lighter, stronger and less expensive than might be otherwise attained through conventional forging, casting and machining operations. Demonstration of reduced part turnaround and delivery with cost savings of 50 percent were a targeted goal. Methods, processes and materials should be functionally integrated via a feature-based design environment allowing selection and optimization of manufacturing methods, processes, and materials for structural aircraft and engine components.

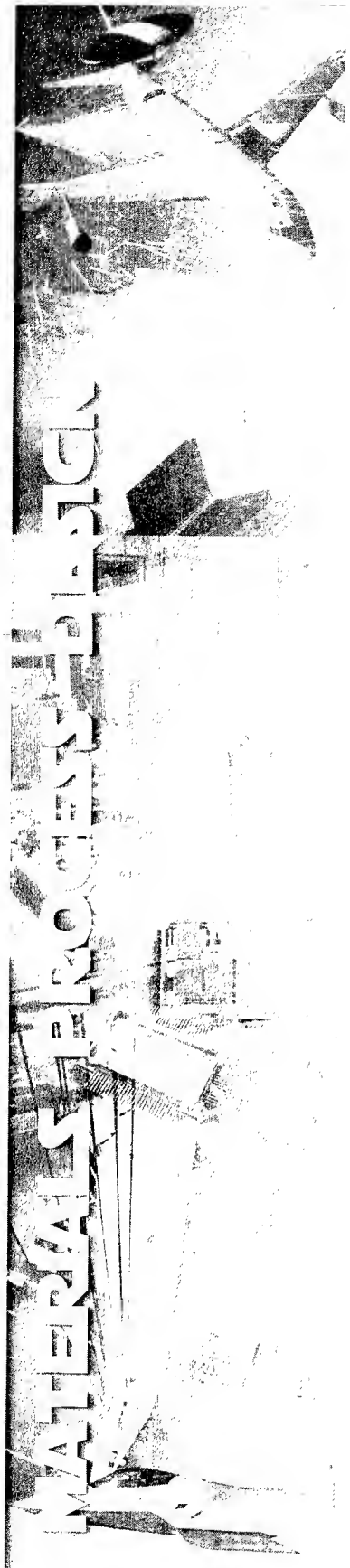
For metal forming processes, a technical strategy was established for embedding analytical models of basic transport phenomena into a feature-based design system which includes geometric, microstructure, and processing features. The system architecture combined user-defined workpiece objects with user-defined sequences of process and equipment objects. Within the system, process objects were coupled with graphical modules to display relevant information (such as speed, load, geometry, etc.) and simplify user interaction with the simulation.

Efforts to improve computational performance of the software have been incorporated. This was accomplished by moving the intensive numerical calculations out of the Adaptive Modeling Language (AML) framework and into external library modules. Substantial speed enhancements (a factor of 10 or more) were achieved. These modules have been developed using MATLAB, a software framework that designed for numerical algorithm development, as the primary rapid software prototyping environment. The environment is currently being tested for application to turbine engine disk manufacturing in cooperation with Rolls-Royce Allison. Also, new numerical design optimization algorithms are being tested within the framework.

Benefits

Reduced weight, cost, design and fabrication times associated with metal forming spare components for aging aircraft systems. The integration of virtual metal forming stages will provide users with important information about various interdependencies and trade-offs among manufacturing stages, and allow for more cost-effective optimizations of complex manufacturing operations.

For more information on this project, contact the Manufacturing Technology Division's Technical Information Center at (937) 256-0194. Refer to #1932.



Materials Processing Technology Initiatives

Contract Number: F33615-96-D-5835
Project Engineer: Dr. Steven LeClair
Contractor: Technical Management Concepts Incorporated
Current Status: Active
Start Date: September 1996 End Date: April 2001

Objective

Advance in-house materials processing (design and control) research which encompasses non-structural tribological coatings and inorganic (though biologically based) electro-optical materials; and structural metal alloys, intermetallics, polymer, metal and ceramic composites in the direction of virtual materials research by the 21st century. Research in areas such as high and low cycle fatigue, nondestructive inspection, super alloys and intermetallics research will benefit from electronic access to Air Logistic Centers' engine inspection results on a continuing basis and evolving both material and processing research in near real-time towards the immediate needs of aging systems.

Research addressed advanced computing and engineering methods for automated materials process analysis, synthesis and discovery, integrated materials-shape-process design and self-directed materials process control. In-house research was transitioned through innovative and novel "need/problem-specific" enhancements and extensions to existing technology. Such enhancements and/or extensions involved interdisciplinary and cross-functional collaboration with Air Force and other customers as well as other federal and state agencies, and defense industrial sectors. The research strategy was to collaborate with other government and industrial organizations with specific technology needs that have the potential to benefit from on-going research results and to facilitate the enhancement and extension of those results.

Of a total of 97 delivery orders to date, on-going efforts involve 56 delivery orders addressing new sensors and/or computational methods for real and/or virtual monitoring, and for modeling and simulating the design and control of materials processes. These methods will be applied to the development of the following materials: non-structural tribological coatings, electro-optical thin films, structural metal alloys, intermetallics, polymers, biogenetics, superconductors, metal matrix and ceramic matrix composites. Research addresses the quality, manufacturability and affordability issues in materials development, with computational methods to automate materials and/or process design at the molecular level. Computational methods are being applied to the development of real-time, self-directed materials process control systems. In addition, the developed methods will enable simultaneous material, process, and shape design for parts and tooling associated with materials forming processes.

Benefits

Advancements in computational methods toward virtual materials and processing research and significant improvements in research quality, costs, and response time. This will enhance technology investments that have been made in the state-of-the-art for materials processing of existing and future aerospace systems. The program will also enable (by means of a materials and processing information highway) transition and transfer of materials processing technology more effectively and to a more pervasive set of applications.

For more information on this project, contact the Manufacturing Technology Division's Technical Information Center at (937) 256-0194. Refer to #1619.

Near Real-Time Monitoring of Thin-Film Materials and Their Interfaces Using Evanescent Microwave Probes

Contract Number: F33615-99-C-5701
Project Engineer: Steve Fairchild
Contractor: Manufacturing Instrumentation Consultant Co.
SBIR Funded
Current Status: Active
Start Date: June 1999 End Date: May 2001

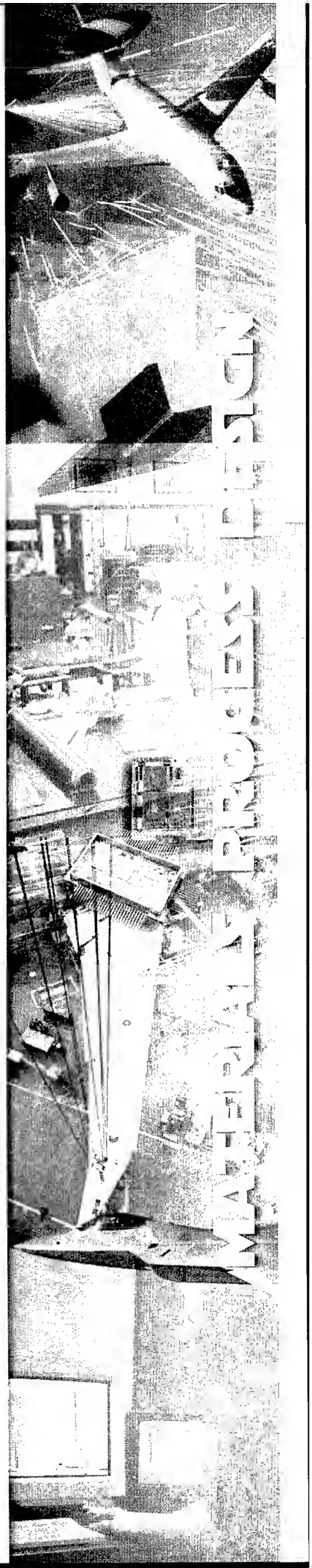
Objective

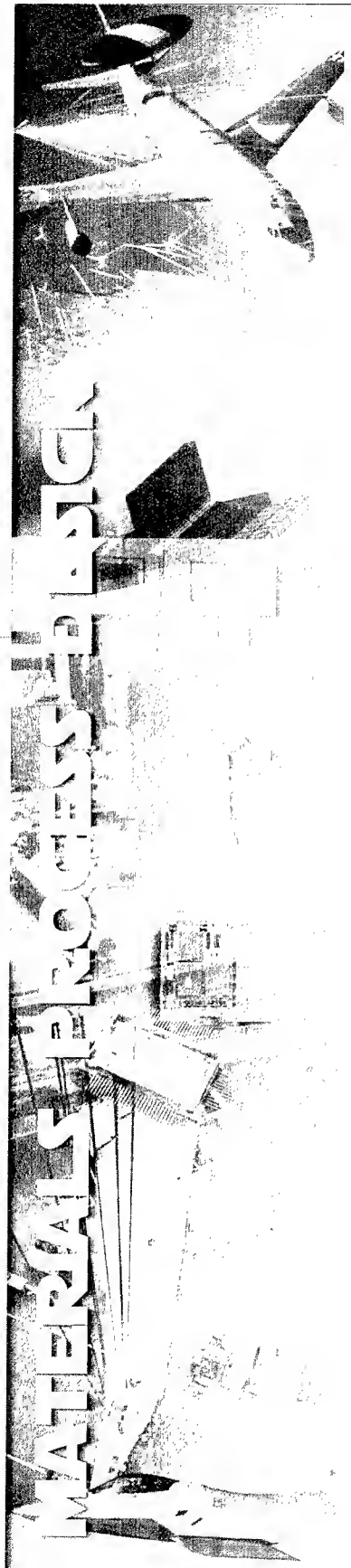
Develop an evanescent microwave probe (EMP) imaging system to provide near real-time feedback on the status and the quality of thin-film growth in a pulsed laser deposition (PLD) chamber. More specifically, this system will provide information regarding morphology, composition, and isotropy of PLD thin-films. With the advent of thin-film composites and multi-layer coatings, atomic-scale monitoring of crystallographic information and stresses will become increasingly important. As compounded by material gradation and interface requirements, 2D uniformity and 3D topographies will drive yet more precise process control in more integral micro-electro-mechanical systems (MEMS). They will also lead to multi-property coatings ranging from threat/detection applications to gradient multi-layer coatings for higher operating temperature engine components, all of which must be grown or removed under environmentally compliant conditions. Many existing in situ monitoring methods are limited to processes below 800° C, thereby limiting thin-film process thicknesses and rates. Simultaneous rapid assessment of a number of variables controlling ultimate specimen quality such as micro-chemistry, surface roughness, interface quality, grain size, preferred orientation and residual stresses are of particular interest. Future advances in materials research will require near real-time in situ data which can be used to automate materials process modeling and expedite the control of gradient thin-film growth and/or removal. Improvements are needed in sensing and signal processing over a wide range of temperatures, i.e., 400° C to 1400° C, via monitoring methods which depend upon fixed time integration to achieve adequate signal-to-noise ratios which often preclude real-time monitoring for purposes of purposes of process control. Using parallel probes operating at different frequencies, this imaging system will provide hyper-spectral information and 3-D maps that can be used to adjust the deposition uniformity and composition.

Benefits

Process control of gradient thin-film materials for extreme environments such as thermal and wear protection for automotive, aircraft, and/or space propulsion systems. Specific examples include real-time process monitoring of surface roughness and microchemistry for painting, cleaning or inspecting of aircraft components, real-time process monitoring of film stresses for ultra-high vacuum processes such as molecular beam epitaxy, and real-time process monitoring of grain size for medium vacuum charged-ion plasma growth processes such as magnetron sputtering.

For more information on this project, contact the Manufacturing Technology Division's Technical Information Center at (937) 256-0194. Refer to #2575.





MATERIALS & PROCESSING

Remarkable Material for Advanced CMC Propulsion Systems

Contract Number: F33615-98-C-5157
Project Engineer: Dr. John Jones
Contractor: Ceramic Composites Incorporated
SBIR Funded
Current Status: Active
Start Date: July 1998 End Date: November 2000

Objective

Demonstrate the ability of Titanium (Ti_3) Silicon Carbide (SiC_2) to extend the performance capabilities of SiC(*f*)/SiC and C(*f*)/SiC ceramic matrix composites (CMCs) for propulsion components. The technical objectives which are necessary to complete this research are: 1) Defining the processing parameter boundary limits for Chemical Vapor Deposition (CVD)/ Chemical Vapor Infiltration (CVI); 2) Development of an intelligent process control system to tightly control the CVD/CVI processing parameters and process output for reproducible Ti_3SiC_2 coating of fabric and net-shape preforms; 3) Demonstration of composite toughening behavior and oxidation resistance for long life component applications; 4) Construction of a reactor for the continuous coating of carbon (C) and SiC fiber tows and cloth.

The development of a remarkable Ti_3SiC_2 material for use in ceramic matrix composite (CMC) fiber coatings and matrix laminates was proposed. In conjunction with Dr. J. Lackey at the Georgia Technical Institutes, CCI worked to demonstrate that this material could be deposited by chemical vapor deposition. This partnership worked to demonstrate that Ti_3SiC_2 could mitigate two of the major limitations of C*f*/SiC and SiC*f*/SiC CMCs for thermal protection and propulsion system applications; the lack of a tough, long life fiber matrix interface coating and particle impact susceptibility. The division of research and development efforts between CCI, Georgia Tech and critical property measurements partners, Southern Research Institute and the University of Cincinnati was as follows: Georgia Tech conducted the preliminary CVD experiments, crystal structure analysis, and fiber coating experiments. They also deposited fiber interface coatings on 2D C*f* and SiC*f* laminate preforms and seal "topcoat" coatings on densified C*f*/SiC and SiC*f*/SiC CMCs. CCI performed the SiC matrix densification of the Ti_3SiC_2 coated C SiC 2D laminate preforms as well as oxidation and thermal stress tests.

Several processing protocols have been developed for promising debond coating compositions under this program. These include Ti_3SiC_2, SiC/TiC multilayers or SiO_2/TiO_2 multilayers with or without a thin C undercoat. All these coatings have displayed composite like fracture behavior. A patent was filed under "Ceramic Fiber Debond Coating" in May 2000. Composite samples have been fabricated and are undergoing extensive mechanical property characterization at Southern Research Institute prior to fabrication of missile thrust chambers. GE Aircraft Engines, Evendale has expressed a strong interest in evaluating the efficacy of this new debond coating in their SiC*f*/SiC combustor program.

Benefits

Provide high temperature, long life fiber debond coating for non-oxide CMCs for a wide range of advanced turbine engine components, principally combustors, turbine inter-ducts, vanes and divergent nozzles. The lighter CMCs will provide increased range, payload and fuel efficiency for weapon systems. The technology also offers major benefits for commercial power turbines where 30,000 hours of lifetime are desired.

For more information on this project, contact the Manufacturing Technology Division's Technical Information Center at (937) 256-0194. Refer to #1726.

Simulation-Based Design System for Multi-Stage Manufacturing Process

Contract Number: F33615-99-C-5708
Project Engineer: Dr. Garth Frazier
Contractor: Technirep Incorporated
SBIR Funded
Current Status: New Start
Start Date: January 2000 End Date: January 2002

Objective

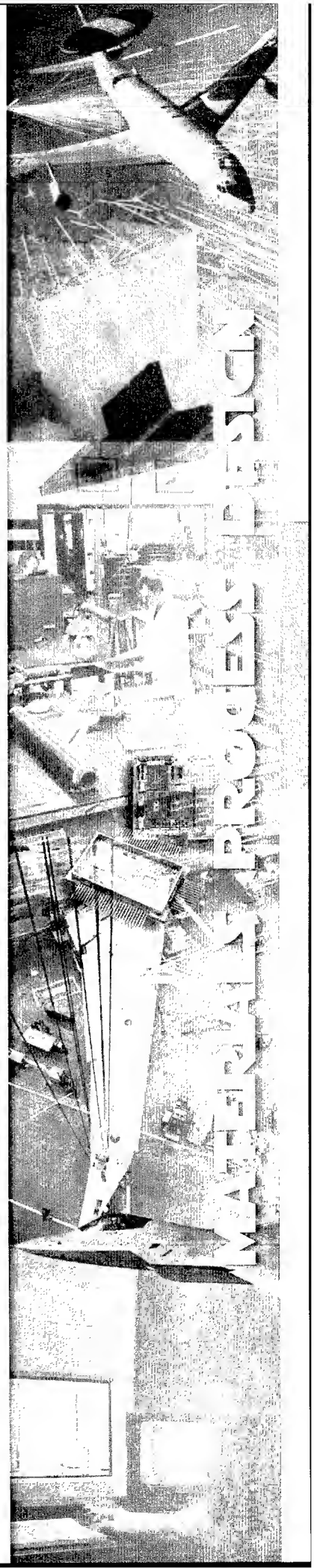
Develop software tools for optimization-based, simulation-driven design of manufacturing processes with an emphasis on 3-D forging design tools. There exists a need to develop a computer-aided approach for the design of reliable and affordable manufacturing processes for difficult-to-form materials that considers alternative materials, sequences of processes, and process parameters, which will yield the most cost effective manufacturing route or solution in a rapid fashion. Manufacturing of components for new aircraft systems, as well as spare components for aging aircraft systems offers methods which consider alternative processing approaches and can lead to significant improvements in component reliability and affordability. To be most effective this approach should be transportable across internet/ intranet/extranet environments and be able to run on current desktop systems.

The approach is based upon systematically combining simplified models of process and material physics with design heuristics and numerical techniques to produce optimized designs for sequences of manufacturing processes.

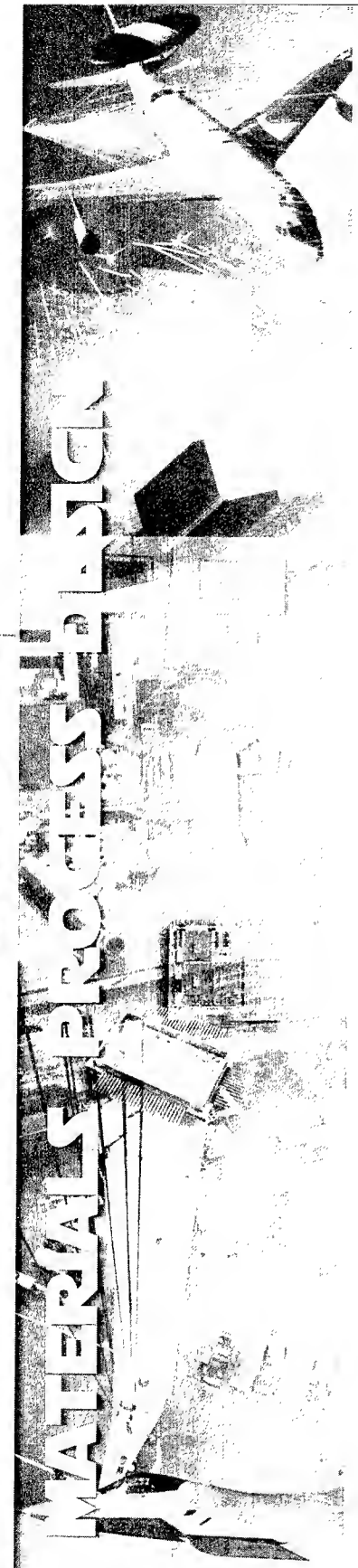
A novel approach for designing preform geometries and blocker dies for complex 3-D structural forgings is being investigated. This technique is based on fundamental principles of multi-dimensional signal processing combined with practical principles of die design.

Benefits

Minimize the number of billet types and blocker dies involved in forging different turbine disks for all Air Force systems, resulting in increased reliability and affordability. This exploratory research will be used in both military and commercial applications for the design and optimization of material, shape, and processing aspects of manufacturing from high performance metals, ceramics, and polymers. Immediate benefits will be obtained from the application of shape optimization techniques to the standardization and optimization of the Air Force supply chain.



For more information on this project, contact the Manufacturing Technology Division's Technical Information Center at (937) 256-0194. Refer to #2678.



Simulation-Based Design System for Multi-Stage Manufacturing Process

Contract Number: F33615-99-C-5709
Project Engineer: Dr. Garth Frazier
Contractor: Modern Computational Technologies Incorporated
SBIR Funded
Current Status: New Start
Start Date: January 2000 End Date: January 2002

Objective

Develop software tools for optimization-based, simulation-driven design of manufacturing processes with an emphasis on heat treating related processes. Manufacturing of components for new aircraft systems and spare components for aging aircraft systems offers great opportunity to introduce innovative material process design methods which consider alternative processing approaches and can lead to significant improvements in component reliability and affordability. Of particular interest is the development of computer-aided design tools that enable the standardization and optimization of the supply chains for parts used by Air Force systems while conforming to proven principles for the design of material processes. This effort will involve the formulation of materials and processing models and their use with simulation and optimization-based design techniques in order to determine processing sequences and parameters that optimize the manufacturing process with respect to quality, performance, and cost.

The approach is based upon systematically combining simplified models of process and material physics with design heuristics and numerical techniques to produce optimized designs for sequences of manufacturing processes.

A novel computational technique for simulated heat treatment response of Ti-6Al-4V is being developed for 2-D axisymmetric components that is significantly faster than finite element analysis (FEA) techniques, but is accurate to within 10 percent of FEA solutions. A variation of the technique is being considered for application to heat treatment distortion.

Benefits

Minimize the number of billet types and blocker dies involved in forging different turbine disks for all Air Force systems, resulting in increased reliability and affordability. This exploratory research will be used in both military and commercial applications for the design and optimization of material, shape, and processing aspects of manufacturing from high performance metals, ceramics, and polymers. Immediate benefits will be obtained from the application of shape optimization techniques to the standardization and optimization of the Air Force supply chain.

For more information on this project, contact the Manufacturing Technology Division's Technical Information Center at (937) 256-0194. Refer to #2799.

Thin Film Growth Simulation Using Cellular Automata

Contract Number: F33615-99-C-5700
Project Engineer: Dr. Donald Dorsey
Contractor: AVXM Partnership
SBIR Funded
Current Status: Active
Start Date: April 1999 End Date: April 2001

Objective

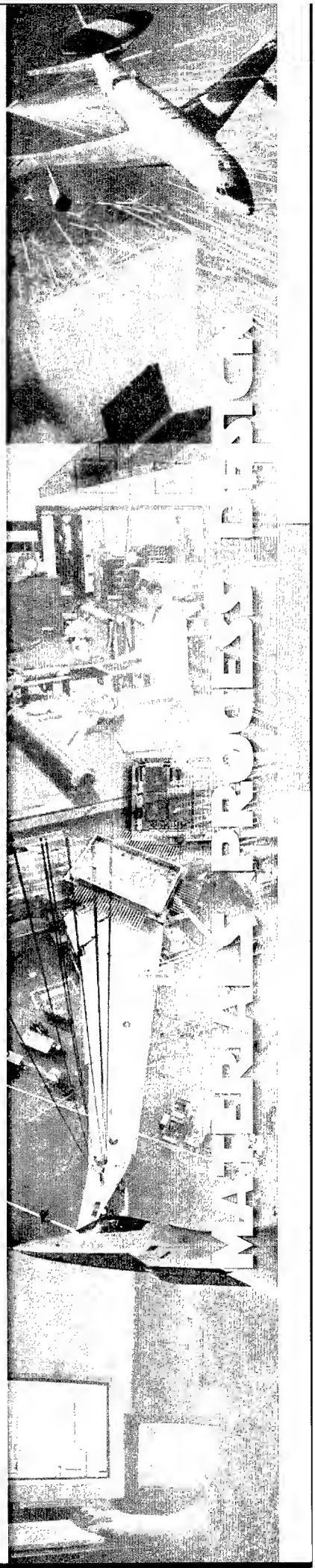
Develop a computationally tractable and user-friendly simulation system for simulating, comprehending, and comparing process-specific thin-film growth. Whether for extension of operating life, performance enhancement, or nano-scale functionality, the growth and/or removal of thin film materials (including coatings) for Air Force applications has established a need for a process modeling of material interfaces between and among various metals, ceramics, semiconductors, and polymers to assess properties and effluents for environmental compliance. A capability to simulate growth/removal conditions is needed to either ensure environmental compliance and/or control desired stoichiometries and crystallographic parameters of interest. This is in addition to the more macroscopic parameters associated with temperature/pressure gradation and rates. More widespread application of embedded nanostructured materials and/or devices from monitoring temperatures and/or vibrations in critical engine components to agile and conformal threat/detection sensors via micro-electro-mechanical systems (MEMS) is limited by the lack of a design environment which can integrate so-called nano or molecular-level design with structural design of monolithic and/or composite materials. Complementary and/or alternative computational methods to intractable molecular modeling methods are required which leverage existing molecular and structural design tools and enable their integration. Materials of immediate interest include high temperature intermetallics, composites, electro-optical semiconductors, and polymers.

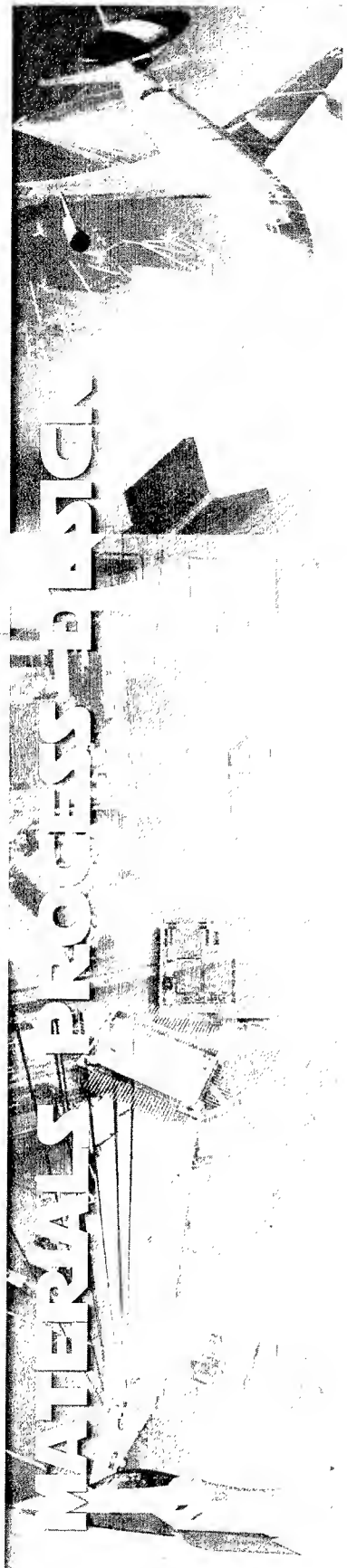
The basic Nanomodeler software developed under Phase I is being extended to include molecular dynamics algorithms. Use of various potential functions in these algorithms provides a means for simulating engineering materials. Long term, such simulations establish the basis for rule formulation required by Nanomodeler and the cellular automaton approach. Cluster collision models based on molecular dynamics code validated via comparison with well-established results are being developed. Use of Java and Open GL allows cross platform use of the code, and it serves as a test model for refining user interface issues. Conversion to more computationally efficient code is also underway where code has been validated.

Benefits

Growth of novel new materials, and the design of a recipe for a nano-scale composite wear coating for a complex surface of a miniature momentum control device for a space probe. In the life extension of aircraft landing gear, the design of the tooling substrate for uniform plating of complex geometry, particularly internal surfaces such as a nose gear trillion, can extend component life, avoid expensive rework and premature failure. Dual use of this exploratory research is expected in areas involving the integrated substrate and thin-film designs for extension of operating life, performance enhancement, or nano-scale functionality.

For more information on this project, contact the Manufacturing Technology Division's Technical Information Center at (937) 256-0194. Refer to #2552.





Web-Based Collaborative Environment With Knowledge Driven Agents

Contract Number: F33615-00-C-5701
Project Engineer: 2nd Lt. Cory Pike
Contractor: TechnoSoft Incorporated
Current Status: New Start
Start Date: July 2000 End Date: July 2002

Objective

Develop a Web-Based Collaborative Environment with Knowledge Driven Agents for monitoring, gathering and organizing activities and interactions that are part of the design process for reuse as knowledge within the context of an application or domain. A web-based cross-platform design environment in a performance-based marketplace made profound changes on the design process as we know it. Fundamental to that change was the perceived exponential growth in participants, not only from various disciplines within an organization or company, but up and down the multi-tiered supply chain, all of whom have the opportunity to converge and engage each other on problems and solutions. The raw speed and potential voracity of such a global 24-hour-per-day design environment, given the undeterred access by all who wish to participate, will be without precedence, and indeed, a paradigm shift in need of work-flow scheduling and dependency-tracking.

TechnoSoft has proposed to divide this work into two basic efforts. First they will develop a web-based collaborative environment with knowledge-driven agents that can be used by the DoD and commercial companies in multidisciplinary, distributed, interactive design activities throughout the World Wide Web. In order to accomplish this effort, they will research the implementation of agents as objects in their existing Adaptive Modeling Language environment, research methods of pattern identification, storage, retrieval, and correlation, and extend the AML environment to support Java applets. After this effort, TechnoSoft plans on demonstrating the use of this environment by monitoring and populating the knowledge-base of existing AML-based applications, such as Lockheed Martin Electronics & Missiles Interactive Missile Design (IMD) for reuse.

Although the contract was just recently awarded to TechnoSoft, progress has already been made in the establishment of a functional web-based design environment (WDE). In conjunction with testing the WDE, TechnoSoft is in the process of determining what types of design actions/events need to be recorded, and how best to store them in such a way that allows for the recognition of patterns by agents invoked by a future designer.

Benefits

Provide the ability to effectively capture the design process knowledge of the engineers/ analysts in an organization and store it in such a way that the knowledge can be reused on future weapon systems designs. This will have a profound impact on the quality and turnaround time of both DoD and commercial systems design. Dual use of this exploratory research is foreseen for the design of systems, more specifically, complex systems found in the automotive, aircraft, missiles, and/or space arenas.

For more information on this project, contact the Manufacturing Technology Division's Technical Information Center at (937) 256-0194. Refer to #2677.

Web-Based Design Environment

Cooperative Agreement Number: F33615-99-2-5704
Project Engineer: 2nd Lt. Cory Pike
Contractor: Lockheed Martin
Sub-Contractor: TechnoSoft, Inc.
Current Status: Active
Start Date: May 1999 End Date: May 2002

Objective

Develop a web-based collaborative environment that significantly improves the interaction among the various disciplines involved in the design process through the use of the Internet. In the demonstration of this effort, the WDE will improve two existing related systems, the Interactive Missile Design and Interactive Gimbal Design.

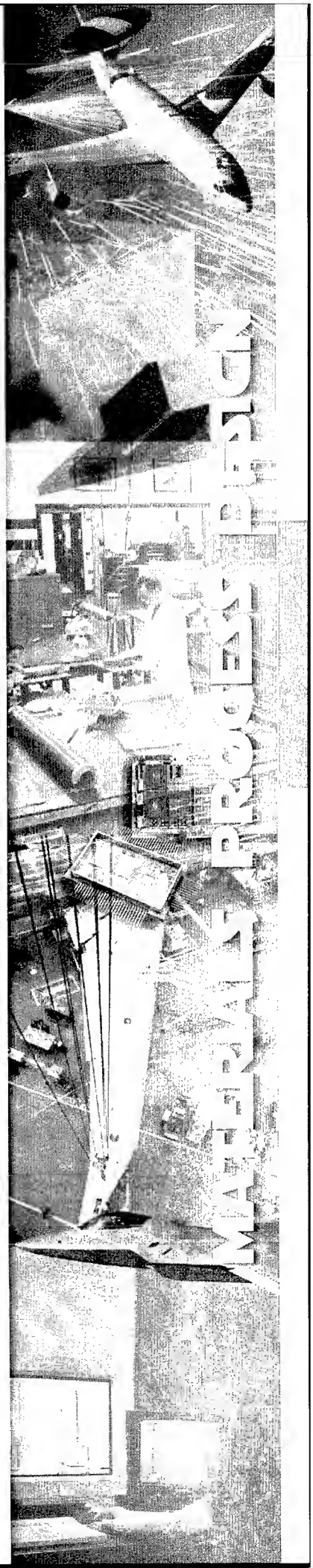
Lockheed plans to divide the project into two basic efforts. The first effort involves the AFRL/Lockheed/Technosoft development of a Web-based Design Environment (WDE) that can be used both by the DoD and commercial design activities throughout the world-wide-web. Upon completion of the WDE, they will apply and demonstrate the use of WDE for performing both Conceptual Missile Design (IMD - Interactive Missile Design) and Conceptual Fire Control Design (IGD - Interactive Gimbal Design) at Lockheed Martin Electronics & Missiles.

Lockheed Martin Missiles and Fire Control-Orlando (LMMFC-O) analyzed/documented current IMD & IGD class/object hierarchies in support of LMMFC-O engineers taking on more of the role of doing AML programming (which is the case when adding customization of IMD or IGD). A specialized orientation/training session was conducted at the LMMFC-O facility. A team of TechnoSoft AML programming specialists gave LMMFC-O engineers a two-week long orientation/training course. As a result, the class and object hierarchies were described and documented, thus providing valuable insight into how the IMD and IGD are internally configured. LMMFC-O demonstrated to the customer the initial version of web-enabled IMD/WDE. Current WDE testing capability is done on a confined Intranet. More rigorous levels of testing incorporate communications over a dedicated line or over the Internet. LMMFC-O and TechnoSoft, Inc. have begun the detailed planning and preparation for testing of the WDE environment over Internet through a dedicated phone data line or a Virtual Private Network.

Benefits

Provide a weapon systems design environment that will facilitate the near real-time interaction among the various organizations and disciplines involved in the design process (i.e. Engineering, Manufacturing, Administration, etc.). Whether the design is conceptual or final, this highly accelerated collaboration will serve to significantly reduce the overall cost of design and the amount of time in which a new design or modification is accomplished while improving the overall quality of the design.

For more information on this project, contact the Manufacturing Technology Division's Technical Information Center at (937) 256-0194. Refer to #2594.



X-Ray Sensors For Real Time Control of Thin Film Deposition

Contract Number: F33615-99-C-5702
Project Engineer: Dr. John Jones
Contractor: Technology Assessment & Transfer Incorporated
SBIR Funded
Current Status: Complete
Start Date: March 1999 End Date: October 2000

Objective

Develop a computationally tractable and user-friendly simulation system for simulating, comprehending and comparing thin-film growth. Intelligent materials processing requires sensors that can assess materials properties in situ and in real time at the microscopic level. Data from these sensors would be used to control processing in near real time, to accelerate development of new materials systems, and to enable the development of a virtual materials processing environment, a goal that will greatly reduce both the cost and time needed to develop new materials systems. Few sensors currently exist that can provide the kind of information needed. X-ray sensors offer a vast improvement over current in situ sensor techniques. Recent advances in high energy high resolution x-ray generators coupled with modern advanced photon detecting systems have made real-time data acquisition during Physical Vapor Deposition (PVD) a laboratory reality. During Phase I of this effort, the feasibility of x-ray sensors for in situ, real-time process control of magnetron sputter deposition of thin films was demonstrated. This was achieved by delineating relationships between microscopic film properties and deposition conditions. In addition, one design was prepared to adapt appropriate sensors for measuring x-ray reflectivity and fluorescence to in situ measurements, and a second design for a heated sample stage and goniometer will be developed. For the Phase II effort, the designs will be implemented, tested and installed at AFRL/ML.

The detailed design of the X-ray sensor system for the AFRL magnetron sputtering system is complete. The design is based on the optimum combination of off-the-shelf components that yield the maximum performance yet permit ease of operation under the geometrical constraints of the existing deposition system. The capability of the in situ X-ray diffraction (XRD) and X-ray fluorescence (XRF) systems to determine crystal structure, residual stress, film thickness and stoichiometry of sputtered films has been assessed in terms of near real time control. The ability to convert XRD and XRF data to image maps for monitoring epitaxial uniformity was also analyzed. A list of novel features which are likely to be patentable has been compiled in preparation of a patent application.

Benefits

Provide a virtual materials processing environment for accelerated development as well as process control of advanced thin-films and coatings, such as those used for extreme environments for aircraft, missile and/or space propulsion systems. Other examples include real-time process monitoring of surface roughness and microchemistry for painting, cleaning or inspection of aircraft components, real-time process monitoring of film stresses for ultra-high vacuum processes such as molecular beam epitaxy, and real-time process monitoring of grain size for medium vacuum charged-ion plasma growth processes such as magnetron sputtering.

For more information on this project, contact the Manufacturing Technology Division's Technical Information Center at (937) 256-0194. Refer to #2553.

Engine Supplier Base Initiative

Cooperative Agreement Number: F33615-95-2-5555
Project Engineer: Rafael Reed
Contractor: Howmet Corporation
Current Status: Active
Start Date: September 1995 End Date: August 2001

Objective

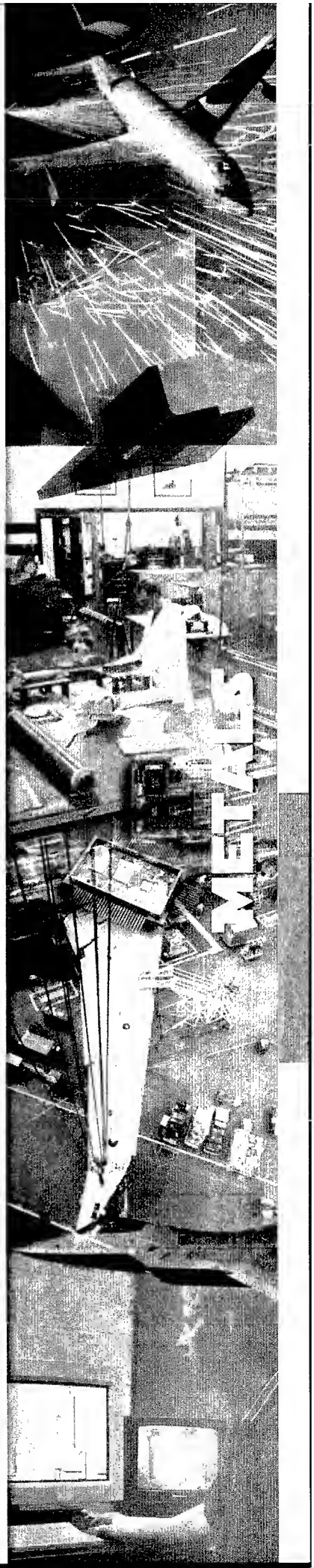
Achieve a 50 percent improvement in quality as related to structural rework, airfoil tolerance and single crystal scrap; and a 25 to 50 percent improvement in production cycle time, tooling procurement, new part design and process development time. Until recently, the industry's technological base was sustained and dominated by the drive to maintain the United States' military edge. With reduced defense spending, engine designers, material developers, and manufacturing engineers must confront a new challenge. In the past, performance at any cost was the military rule. However, the future of the gas turbine engine industry will be based not only on performance but affordability as well. A need exists to establish a national initiative to address the affordability of gas turbine engines by attacking the high cost areas known to exist. This program is aimed at providing more affordable propulsion by identifying and attacking high cost manufacturing processes and business practices within the military engine supplier base community. This effort will address the affordability of gas turbine engines by effectively coupling advanced technology tools, new business practices and policies, and lean principles. This is aimed at the investment casting sector. The majority of the manufacturing related to this particular sector is conducted at the supplier base. This effort will be lead by the investment casting supplier base community with the engine manufacturers as team members defining the requirements. Emphasis will be placed on reducing lead times for prototype and production castings, significant reduction in rework of structural castings, reduction in scrap rates of airfoils, and elimination of redundant specifications.

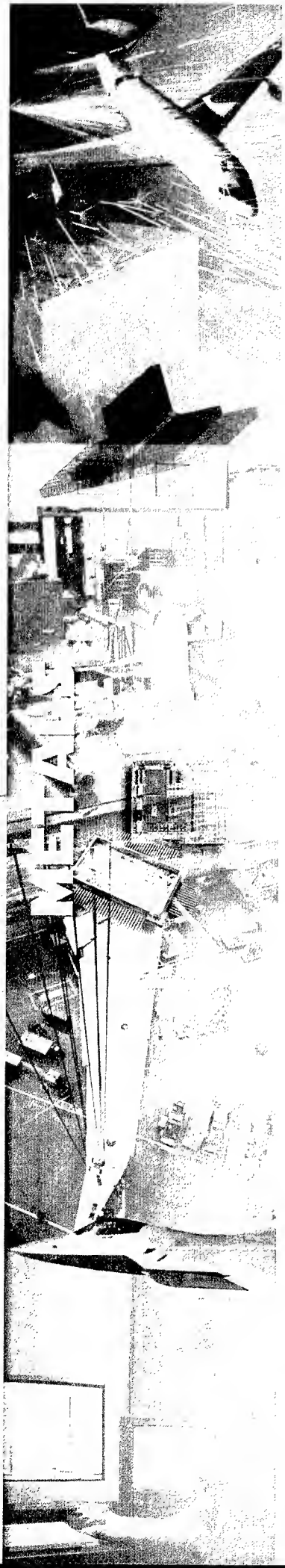
As part of the Casting Supplier Initiative, Howmet's Morristown Casting Support Facility, in Morristown, TN, is conducting a set of projects that influence the cost and quality of ceramic cores supplied to all Howmet casting plants. The Core Dimensional Improvement project has a goal of a 50 percent reduction in the standard deviation of the fired core contour. As a result of several process improvements, the standard deviation has been reduced by approximately 35 percent so far, and the remainder of the goal is expected to be achieved through continuous improvement efforts. The Reduction in Broken, Cracked and Chipped Cores project is trying to reduce core breakage by 50 percent over the life of the program. A pilot production activity is showing the capability to reduce cracking during the core-firing phase. An approximate 30 percent improvement has been made since 1999, with a December 2000 target of an additional 10 percent.

Benefits

Enable the United States to maintain its technological superiority in the gas turbine engine business by providing affordable propulsion for future weapon systems. The program will reduce the cost of investment cast gas turbine engine components by 50 percent.

For more information on this project, contact the Manufacturing Technology Division's Technical Information Center at (937) 256-0194. Refer to #1265.





Forging Supplier Initiative

Cooperative Agreement Number: F33615-99-2-5303
Project Engineer: Kevin Spitzer
Contractor: Pratt & Whitney
Current Status: Active
Start Date: June 1999 End Date: July 2002

Objective

Re-invent the way forged products are produced to achieve a 35 percent cost reduction. In this program, three key objectives will be achieved: concurrence throughout the forging value stream that 35 percent cost reduction can be achieved; establishment of a common process vision (radical redesign) to achieve the goal; and validation of process elements that enable the radical redesign.

Forged components comprise approximately 32 percent of the cost of a propulsion system. Accordingly, plans to reduce aerospace product cost must include the forged product value stream. Traditionally, members of the forging value stream viewed a 35 to 40 percent reduction in cost as impossible for two reasons. First, the adversarial relationship between Original Equipment Manufacturers (OEMs) and forge suppliers has been characterized by tough price negotiations, which keep process details secret and optimized only within corporate walls. Second, the cyclic nature of the market demand further aggravates the relationship by swinging the negotiating leverage to suppliers during periods of high demand and to OEMs during periods of low demand. However, the recent emergence and acceptance of the concept of Lean Manufacturing is making possible the once unachievable goal of a 35 - 40 percent cost improvement. The concept of Lean Manufacturing is based on a total waste reduction strategy requiring a thorough understanding of value by all members in the stream – a teaming approach to improve the whole. The tools for optimizing the whole include business and manufacturing process re-engineering methods, such as process mapping and redesign, benchmarking, and introduction of new manufacturing technologies. The low-tonnage rotary disk forging demonstration was successfully demonstrated on a full-scale aluminum component. The team is now preparing for the titanium disk demonstration. In addition the team developed a 35 percent reduced cost rolled ring strategy which includes a commercial process modeling tool developed and demonstrated for ring forging (rolling) as no other modeling tools exist for rolled ring forging process. This is important because it will allow a dramatic reduction in the input weight of rolled rings. Other process enhancements evaluated, and which will continue to be evaluated, include laser deposition for non-symmetrical features on rolled engine cases. This cost reduction, coupled with an additional reduction facilitated through the use of subsequently added features, will allow an approximate 32 percent reduction in the cost of fabricating fan cases.

Benefits

Reduce weapon system cost and provide or enhance more efficient use of the nation's ever- shrinking resources needed to adequately provide the warfighter with affordable and sustainable weapon systems into the next century.

For more information on this project, contact the Manufacturing Technology Division's Technical Information Center at (937) 256-0194. Refer to #2181.

Laser Shock Peening of F119 Integrally Bladed Rotors Rapid Response Process Initiative

Contract Number: F33615-00-C-5304
Project Engineer: David See
Contractor: LSP Technologies Incorporated
Current Status: New Start
Start Date: April 2000 End Date: March 2001

Objective

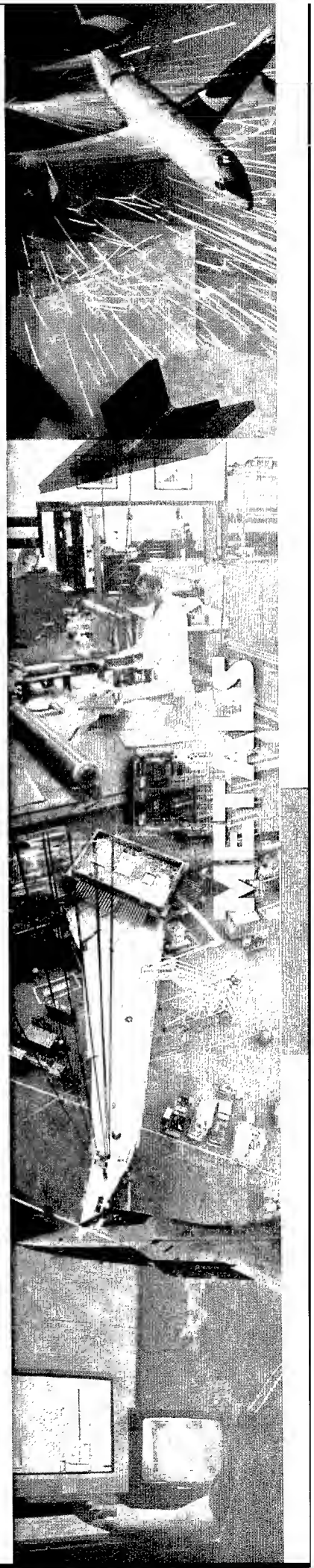
Increase damage tolerance and improve repairability of the fourth-stage Integrally Bladed Rotor (IBR) of the F119 engine.

The program is broken into five tasks as follows:
1. Modify and implement the Rapid Coater™.
2. Production harden the IBR Cell
3. Implement quality controls and monitors.
4. Fully integrate the IBR cell to the manufacturing cell.
5. Implement an airfoil-edge tracking system.

An airbrush design has been identified as a potential means to get the paint applicator in between the airfoils of the IBR. Modifications to a commercially available airbrush are being planned and fabrication of prototype components is expected to go into fabrication soon. An existing design for a debris-removal cone has been evaluated and design modifications are underway. Closed circuit television equipment is being identified for incorporation into the IBR cell.

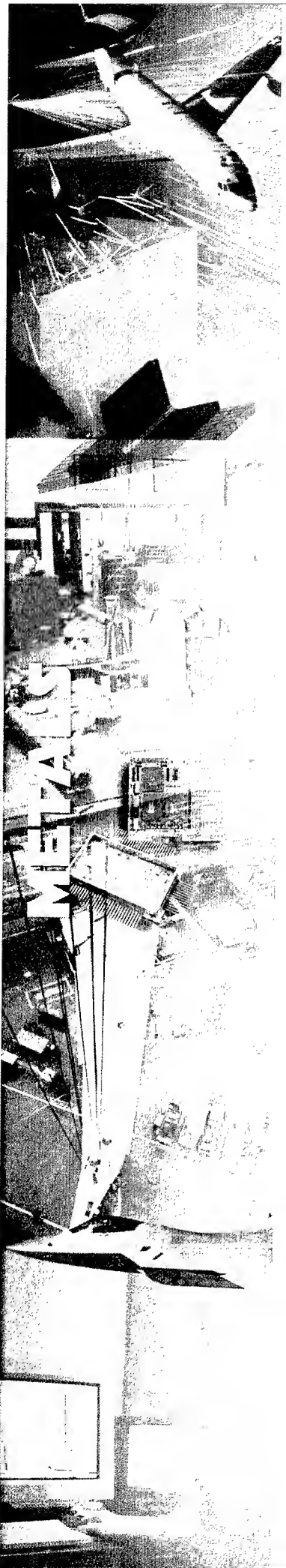
Benefits

Provide more durable aircraft engines, making the warfighter less prone to accidents from foreign object damage. If successful, this program will result in a cost avoidance of more than $10 million for a redesign of the F119 compressor case and the negative impact of increased schedule and retrofit. In addition, this program will lower cost and increase throughput for laser shock peening large parts such as IBRs.



Manufacturing Technology USAF

For more information on this project, contact the Manufacturing Technology Division's Technical Information Center at (937) 256-0194. Refer to #2692.



Lean Blade Repair Pilot

Contract Number: F33615-93-C-4301
Project Engineer: Rafael Reed
Contractor: General Atomics Corporation
Current Status: Complete
Start Date: September 1993 End Date: October 2000

Objective

Establish advanced manufacturing technology for cost-effective semi-to-automatic repair processes for selected high performance gas-turbine engine components. These technologies were installed at Oklahoma City Air Logistics Center (OC-ALC). This effort involved selecting the most efficient and cost-effective process between laser and pulsed-arc welding technologies. Stringent mission requirements have resulted in engine manufacturers using advanced superalloys such as directionally solidified (DS) and single crystal (SC) in novel airfoil configurations. These advanced alloys typically have limited weldability. The current repair techniques consist of rebuilding worn blades primarily through manual welding operations. Current manual repair methods do not have the repeatability to produce a cost-effective repair. A flexible, automated welding machine (FAWM) will meet the requirements to weld-repair blades currently being repaired, and meet future blade repair requirements.

The goal of this Air Force Manufacturing Technology program was to demonstrate advanced manufacturing concepts and technology to improve the quality and reduce the repair cycle time of high performance gas turbine engine components in the Blade Repair Facility at OC-ALC. The project sought to: improve process design and analyses to the Propulsion Production Division in implementing advanced manufacturing concepts and practices in the facility; construct a computer model of the jet engine overhaul and repair process; to develop, validate, and install an automatic tracking system for in-process turbine blades. The program drew upon the information developed by previous modeling as well as manufacturing practices and principles used in industry. Where possible, improvement actions were implemented immediately but where necessary, improvement actions requiring the purchase, and/or installation of additional equipment will be implemented later. Throughout the program, success was measured by improved cycle times, decreased inventory, and improved quality, resulting in improved customer responsiveness and elimination of wasted resources.

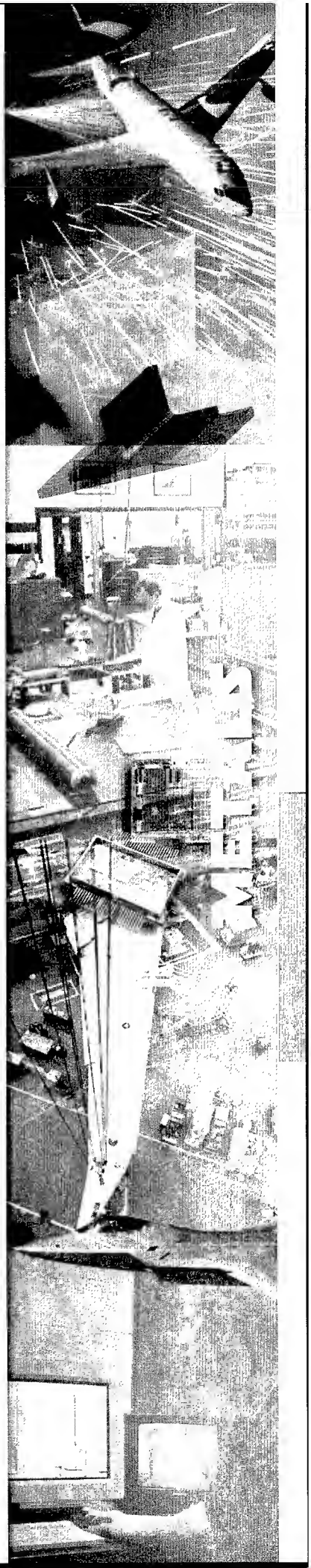
The effort has and will continue to identify engine repair requirements and bottlenecks for advanced propulsion system components as candidates for the implementation of advanced manufacturing concepts. The team has identified the integration of the stators and nozzles into a single workcell as the advanced manufacturing concept demonstrator. Work has been completed on the development and implementation of the automated blade tracking system.

Benefits

Increased affordability of gas turbine engines by reducing scrap by 30 percent, reducing the cost of blade and blade-tip overhaul, and providing a new capability to process thin-walled hardware. The task included an option to design, fabricate, and install the FAWM for a variety of Navy blade and vane components at Cherry Point Naval Aviation Depot. Potential cost savings is about $24 million over two years.

For more information on this project, contact the Manufacturing Technology Division's Technical Information Center at (937) 256-0194. Refer to #314.

Lean Depot Repair (LDR)



Contract Number: F33615-99-C-5307
Project Engineer: John Crabill
Contractor: Southwest Research Institute
Current Status: Active
Start Date: May 1999 End Date: May 2004

Objective

Implement the Lean Thinking philosophy (specify value, identify the value stream, make the value stream flow, initiate demand or pull scheduling, and continuously improve) in maintenance, repair, and overhaul (MRO) areas at Warner Robins Air Logistics Center.

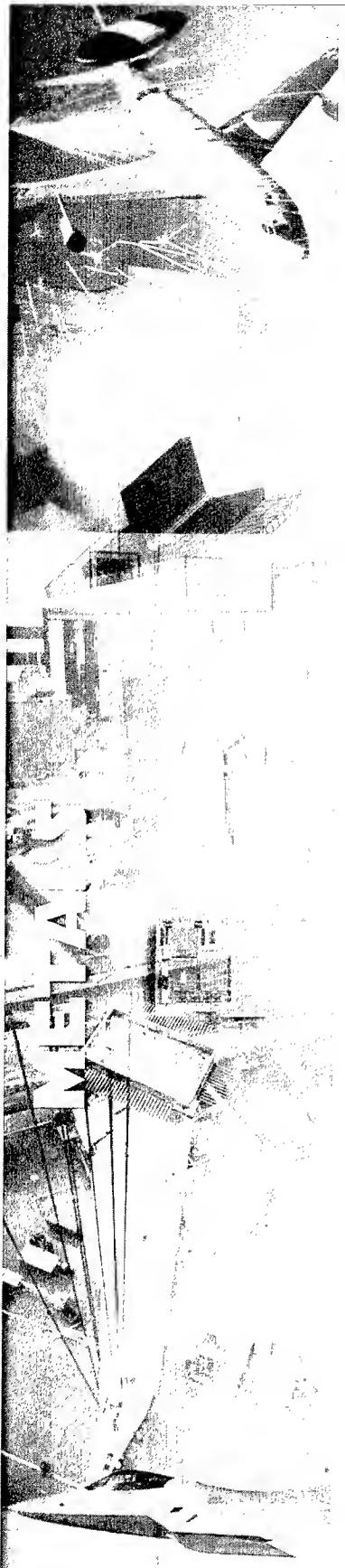
In order to reduce weapon system cost of ownership and accomplish affordable readiness, this effort is focused on repair cycle improvements. LDR is impacting the repair cycle by maximizing improvements to inventory control and management, and to supplier relationships. Impediments associated with these requirements are numerous. Mass production philosophies in inventory management and an unresponsive supply system are preeminent barriers. The status of the item awaiting repair is variable. The bill of materials is uncertain. These conditions create a need for high inventory levels to support readiness; nonetheless, parts shortages are prevalent. Strict application of continuous flow principles may not work in this environment; a systemic approach such as the Lean Thinking approach must be adapted to this complex problem. Lean Thinking is a well documented, successful model for meeting customer requirements right on time in a medium-to-high volume production situation. It is characterized by minimal in-process inventory and single piece flow. Application of Lean Thinking principles to an MRO enterprise dominated by low volumes and high mix presents considerable technical, cultural and business challenges. Successful implementation of Lean Thinking requires some common tenets: strong management commitment towards affecting dramatic change, often exemplified by changes in measurement systems; intensive employee involvement through extensive training and self managed teams; near perfect quality at all levels of production; a total productive maintenance concept wherein production and plant maintenance operate as a partnership; minimized setups commensurate with very small lot sizes; a streamlined factory layout to facilitate movement of materials and operators; a system of production flow based on demand pulls from the next operation; synchronization of materials, operations, and employees to maintain balance; and integration of key suppliers at relevant stages of production.

The specific adaptation of Lean Thinking principles in support of this repair activity will be captured in reports made available throughout the Air Force MRO industrial base (civil and organic). Key policy change recommendations will be highlighted to facilitate lasting improvement

Benefits

Improved MRO capability due to reduced repair work-in-process inventories, improved predictability of repair flow time, reduced repair cycle times, reduced flow time of repair assets, and fewer delays due to parts shortages and awaiting parts conditions. To the warfighter, this means less aircraft downtime.

For more information on this project, contact the Manufacturing Technology Division's Technical Information Center at (937) 256-0194. Refer to #2616.



Lean Sustainment Initiative

Contract Number: F33615-96-D-5101
Project Engineer: Jeffrey Smith
Contractor: GRC International, Massachusetts Institute of Technology
Current Status: Active
Start Date: April 1997 End Date: December 2002

Objective

Foster a collaborative partnership between the private and government providers of Maintenance Repair and Overhaul (MRO) services to the Air Force, with the leadership and support of the Director of Logistics, Headquarters, Air Force Materiel Command. This program builds off the Sustainment 2005 Organic Industrial Base assessment which examined areas within the depot maintenance structure requiring fundamental change, either through technology insertion or adoption of supportive business policies and practices. The aging force structure and diminishing budget have elevated the importance of the sustainment mission. This project will provide an academic research capability to the Air Force depot maintenance services providers, both private industry and organic organizations, to identify and implement lean production practices in the Maintenance Repair and Overhaul (MRO) enterprise. This program is expected to stimulate fundamental change within the entire sustainment enterprise as the effects of leaner MRO operations are felt.

Initial academic research support is coming from the Massachusetts Institute of Technology (MIT) due to their unique background and extensive documentation of lean production practices and principles. Three research focus areas have been identified by the government/industry/academia participants for initial study by focus teams. Led and staffed by government and industry stakeholders and supported by MIT researchers, the focus teams will conduct the research and provide recommendations for implementation. The focus areas are Sustainment Operations, Business Practices, and Enterprise Integration. Within these focus areas, the teams will initially concentrate on Materials and Parts; Requirements Definition and Forecasting; and Goals, Objectives and Metrics. This Initiative is unique in the experience of the depot maintenance community because of its broad collaborative nature. The partnering of government and industry providers is expected to address and resolve common impediments to effective warfighter support. It is anticipated that, as the Initiative progresses, additional priority research areas will be identified. The results of the Initiative may also find an application in the growing civilian MRO market in the United States.

Benefits

Improve cost and responsiveness of the depot maintenance community to the warfighter through world class managerial research and a collaborative effort between government and private MRO providers. Lean production "best practices" will be identified and considered for adoption by the depot maintenance leadership. The Air Force depot maintenance community, both private industry and government, will improve their cost and responsiveness to the warfighter.

For more information on this project, contact the Manufacturing Technology Division's Technical Information Center at (937) 256-0194. Refer to #1284.

Lean Transition of Emerging Industrial Capability (LeanTEC)

Cooperative Agreement Number: F33615-97-2-5153
Project Engineer: John Crabill
Contractor: The Boeing Company
Current Status: Active
Start Date: December 1997 End Date: August 2001

Objective

Use Lean practices and principles to identify new methods for the timely and affordable insertion of advanced technology into weapon systems. This program targets those process improvements within a manufacturing enterprise that enhance the transfer of advanced technology from the development laboratory to manufacturing. It will also result in benefits in product performance and quality and reduced cost and development-to-implementation cycle time.

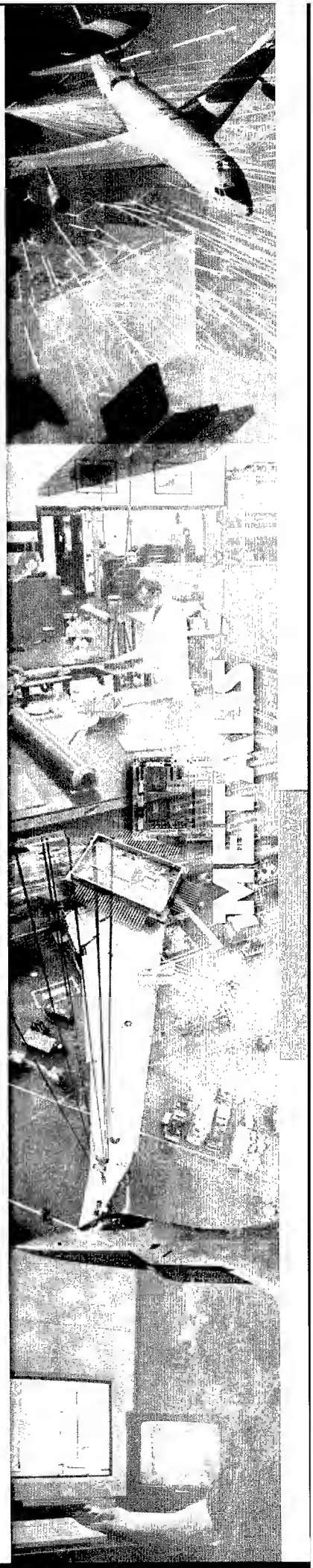
Candidate technologies will be selected to assess the technology transition process. Technology transition barriers and new methods/strategies will be identified for dealing with barriers. A model of the "As-Is" technology transition process will be structured, as well as a model of the "To-Be" technology transition process. Experiments will be formulated and conducted to validate improvements and benchmarks in the "To-Be" model. Results will be quantified in terms of improved technology transition into Air Force aircraft and will be widely disseminated within the LAI community.

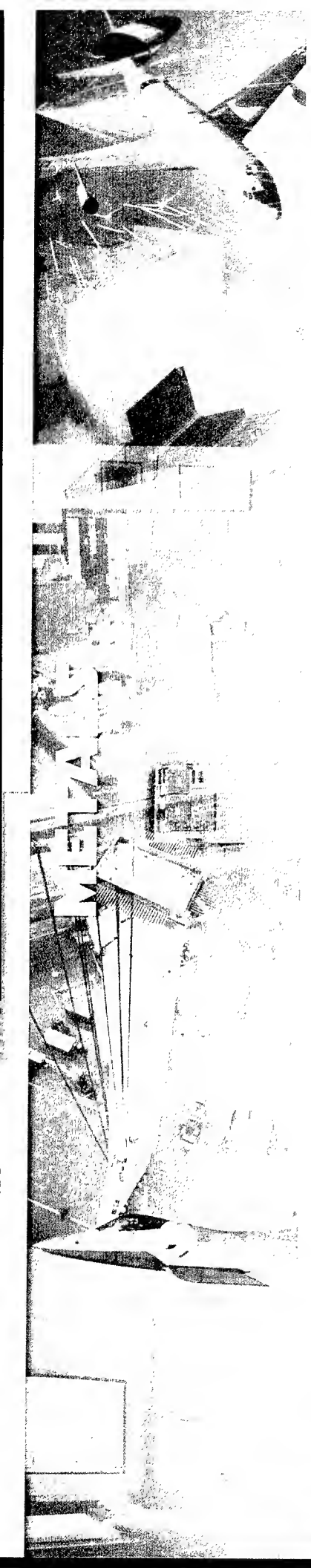
The commitment of resources for research by both government and industry has not been effectively leveraged into tangible benefits. The LeanTEC program concentrates on the transition of emerging technology (both hardware and processes) to existing products. The LeanTEC team is conducting demonstrations of processes, procedures, and management tools that produce a substantial improvement in the "Lean" transition of technology to product. The LeanTEC team approaches the transition process from both strategic and tactical points of view, which includes technology selection, management of resources, management of transition, and team-based issues. The LeanTEC team has conducted an information gathering task. One goal of these efforts was to identify the "big hitters" from the long list of items that often inhibit or enhance Lean technology transition for historic projects as determined by industry professionals. The large database and ready access to industry professionals enabled not only significant statistical inferences, both direct and conditional, but also substantial cause and effect information. The analyses of this data and information led to the selection of 18 major solution elements that are the most likely to make substantial improvements in technology transition.

Benefits

Provide improved processes, procedures, and practices for implementing advanced technology into Air Force weapon systems, providing the potential for saving millions of dollars on future advanced technology transition and insertion.

For more information on this project, contact the Manufacturing Technology Division's Technical Information Center at (937) 256-0194. Refer to #1679.





Lean Value Chain for Critical Part Procurement

Contract Number: F33615-98-C-5168
Project Engineer: John Barnes
Contractor: Knowledge Based Systems Incorporated (KBSI)
Current Status: Active
Start Date: April 1999 End Date: September 2002

Objective

Develop and demonstrate the tools and technologies to promote the rapid acquisition of critical spare parts in support of programmed depot maintenance. Depot logistics repair operations typically rely on a probable bill of materials in the maintenance, repair and overhaul of subsystems such as engines, landing gear, electronics, hydraulics, air-powered accessories, etc. This creates a variable demand for spare parts needed to complete scheduled repair; specifically, 80 percent of material items used in repair are listed by the Air Force Material Command (AFMC) as unpredictable. Spikes in this demand or long periods between a need for certain parts often lead to part shortages which cause the subsystem being repaired to be placed in an idle status called AWP (awaiting parts) until the required part(s) can be found, manufactured, or purchased. Roughly 20 percent of subsystems get placed in AWP status spending an average of six months in that status. Based on the millions of parts procured with a budget measured in billions of dollars each year, the levels of subsystems held in AWP status has become an extreme burden and a high priority problem in AFMC.

The project is using a cyclic development process with three development cycles. Each cycle adopts lessons learned from previous cycles and improves previously installed capabilities, adding new capabilities beyond those of earlier cycles. The tools and technologies will be used to develop lean processes for pervasive repair needs with regard to critical part acquisition.

Work on cycle two began in April 00. The principle cycle one product, the Kit Content History Tool, has been installed and Logistics customers are so pleased with the results that three major purchases have resulted allowing them to install the prototype system into additional shops. While the project is not yet half complete, the accumulated savings are already approaching the total program expenditure of $3.3 million. Conservative projections show potential savings of the completed project will exceed $5 million per year

Benefits

Reduce aircraft down time by reducing the cycle time required to procure critical parts by 50 percent. This will result in a reduction of time spent in AWP from the current six months down, to a maximum of three months. Early indications are that the three-month target may be significantly reduced. The tools provided by this project would also provide significant increases in part inventory visibility to the shop floor. Current operations show that direct labor personnel spend from 10 to 50 percent of their time searching for needed parts; the use of Lean Value Chain for Critical Part Performance tools will reduce this wasted time down to virtually zero. The customer has already indicated that the tools provided have allowed a noticeable increase in direct labor available for repair operations and workload backlog is being reduced.

For more information on this project, contact the Manufacturing Technology Division's Technical Information Center at (937) 256-0194. Refer to #2564.

Manufacturing for Repair Using Best Commercial Practices

Contract Number: F33615-99-C-5306
Project Engineer: John Barnes
Contractor: TRW Incorporated
Current Status: Active
Start Date: June 1999 End Date: February 2001

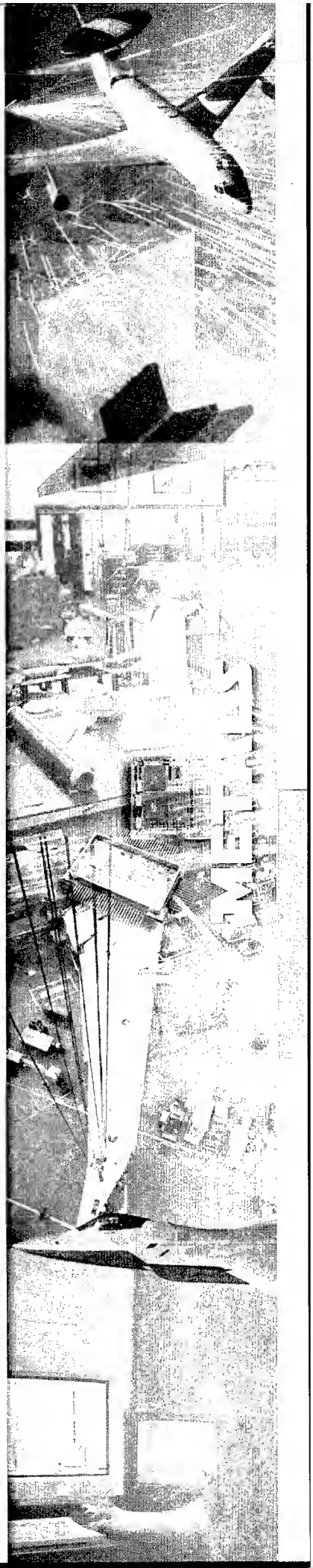
Objective

Design, build and install a manufacturing planning, scheduling, workflow management and control system at Warner Robins Air Logistics Center. This project will improve the flexible responsiveness of government facilities using the best commercial practices. This effort will build upon advancements made in the project "Military Products from Commercial Lines" (MPCL). Under MPCL, a commercial circuit board manufacturing line was modified to build military products on an as-needed basis. This created a lean, agile product line that was both cost-effective and responsive to quick changes in the product line. This effort will incorporate the lean, agile processes incorporated in the commercial sector and apply them to an equivalent government circuit board production facility. Critical changes to the government line are in the area of planning, scheduling, shop layout, technical data management, and operations management of the overall shop.

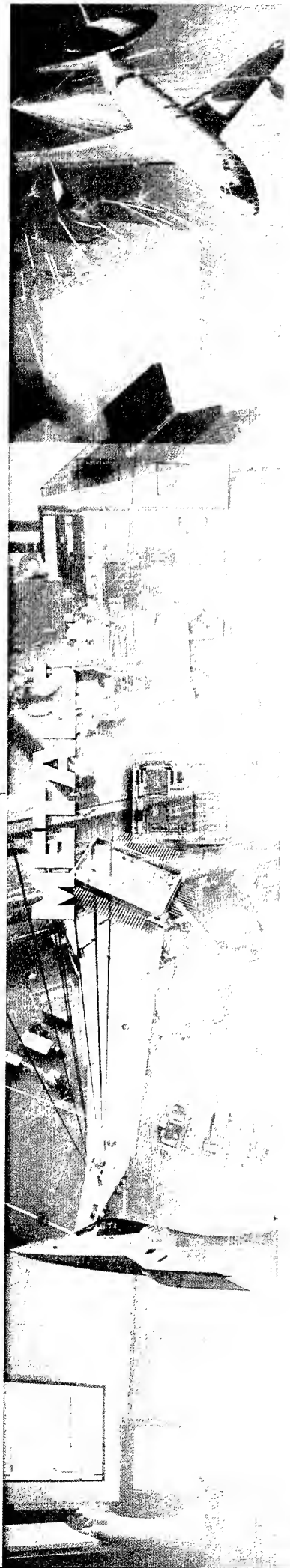
The requirements analysis, system design and development have been completed. A complete system walk through was completed at the contractor's facilities in Warner Robins, GA and approval was given for implementation of the system in the government's avionics manufacturing complex on Robins Air Force Base. The system has been installed and is operational. The major shop operations being initially supported include engineering, planning, printed wiring board assembly, hybrid board manufacturing, cable manufacturing, the machine shop, and the shop in-process inventory warehouse.

Benefits

Provide more affordable weapon systems by incorporating lean, agile processes from the commercial sector into production of government circuit boards. Manufacturing production personnel will operate more efficiently and be able to react to changing workload requirements much more quickly. Improvement in set-up time will result from more detailed production planning and access to better product data. The effort will result in an expected cost avoidance in excess of $1 million per year with potential to achieve upwards of $2 million per year. Many other government production sites will benefit from these process improvements, thus greatly increasing the long-term benefits.



For more information on this project, contact the Manufacturing Technology Division's Technical Information Center at (937) 256-0194. Refer to #2586.



Manufacturing Technology for Affordable Laser Shock Peening

Contract Number: F33615-98-C-5150
Project Engineer: David See
Contractor: LSP Technologies Incorporated
Current Status: Active
Start Date: August 1998 End Date: February 2002

Objective

Design, develop and implement a production-capable laser shock peening manufacturing cell for applications to gas turbine engine blades and other fatigue critical components. Two cells will be created: one within a system builder's facility (to be used for follow-on development and industry sector service) and the other within an aerospace gas turbine engine manufacturer's facility. To date, the primary focus for laser shock peening has been on processing turbine blades with sub-optimized equipment at low production rates. Under this program, all aspects of laser shock peening will be addressed through a systematic approach to increase workload flexibility, increase production throughput, and reduce processing cost and processing time. The program will simultaneously develop the business case required to transition laser shock peening to other industry sectors.

This effort will focus on:

a) developing a robust manufacturing cell for laser shock peening that is flexible enough to accommodate a wide variety of components;

b) incorporating advanced monitoring and control techniques into the manufacturing cell to increase process reliability and repeatability;

c) incorporating partially-automated peening cells into the manufacturing cell to increase throughput;

d) developing and executing an effective business strategy to commercialize laser peening across all market sectors by making available laser peening manufacturing cells to those parties interested in obtaining the technology and by providing an industry capability; and

e) validating the manufacturing cell's performance.

Additional laser and process controls and monitors have been identified and evaluated. Testing has demonstrated that the final system will operate at 1.25 Hz (0.8 seconds between laser peening steps). Full-scale demonstrations of the prototype peening cells have been successfully completed. Several technology enhancements have been successfully demonstrated and will be implemented into the new laser peening system to improve system reliability and maintainability. The market commercialization plan was completed. The new system design is nearly complete and fabrication and assembly of some components of the system are underway.

Benefits

Protect the warfighter from accidents due to foreign object damage by using laser shock peening to strengthen the turbine engine blades. This program will establish a commercial source for laser peening services and laser peening equipment. The robust manufacturing cell currently in fabrication will result in a supplier of laser peening services at costs approximately four times lower than current laser peening costs.

For more information on this project, contact the Manufacturing Technology Division's Technical Information Center at (937) 256-0194. Refer to #1713.

Metals Affordability Initiative – (DUST)

Cooperative Agreement Number: F33615-99-2-5216
Project Engineer: Kevin Spitzer
Contractor: Pratt & Whitney
Current Status: Active
Start Date: September 1999 End Date: March 2005

Objective

Develop significant metals processing technologies and enable a 50 percent reduction in the acquisition cost of metallic components, while accelerating implementation time for new or redesigned products.

Metal alloys are the most pervasive material in man-rated gas turbine engines and are a significant fraction of most airframe structures. Current metals-based engine/airframe systems such as the F-14, F-15, F-16, and F-22 will still be in place through the first quarter of this century. Approximately 80 percent of the engine material content for future fighters will be metal. The time it takes to mature materials from research and development to manufacturing production is still about 15 years. The vision for this initiative is to achieve affordable metallic materials and processes with accelerated implementation for aerospace systems.

The Metals Affordability Initiative (MAI) is based on a systems perspective with three primary *Thrust Areas* that address key drivers of recurring aircraft and engine cost:

• *Affordable Metal Products* — Developing methods to reduce the cost of raw materials and the amount of metal (input weight or buy-to-fly [BTF] ratio) used to produce components.

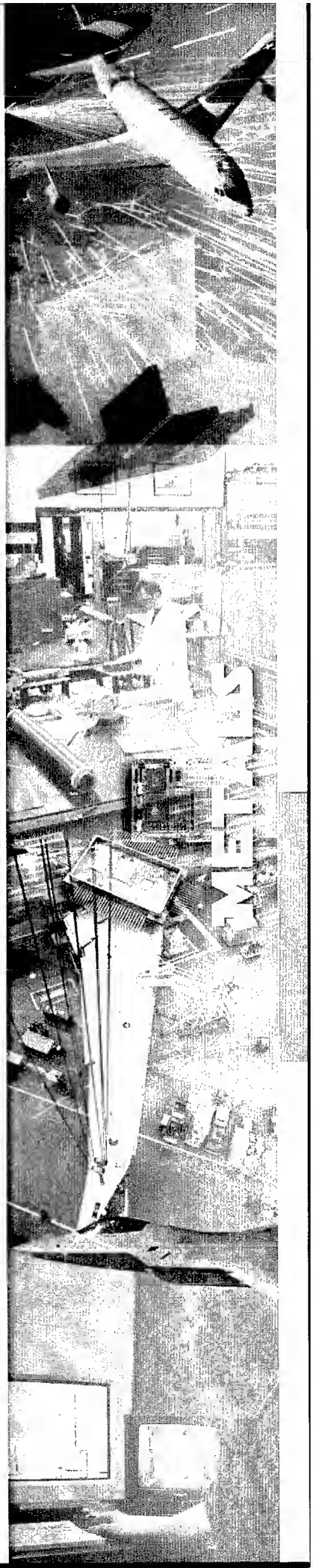
• *Supplier/Original Equipment Manufacturer (OEM) Collaboration* -Lowering part cost by integrating the supplier's technologies and expertise with the OEM's design environment.

• *Manufacturing for Unitization* — Implementing manufacturing methods that reduce part count and simplify fabrication of complex parts through unitized designs.

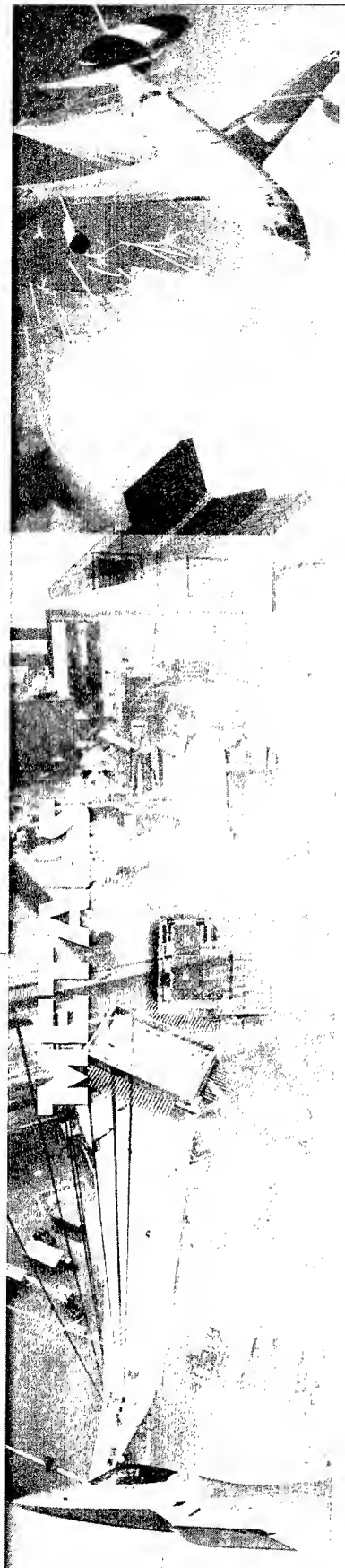
The technical approach will include metals processing projects for technologies and methods that have been technically demonstrated and are sufficiently mature to ensure near-term implementation into military and commercial products. This Dual Use Science and Technology (DUST) project represents the initial effort to support the foundational tenets of the MAI strategy.

Benefits

Provide the warfighter with more affordable weapon systems by achieving metal product manufacturing cost reductions that directly benefit military products. The near-term potential will allow initial implementation in aircraft that are in the early stages of production. Mature aircraft would benefit where the business case for re-engineering with MAI technologies is favorable.



For more information on this project, contact the Manufacturing Technology Division's Technical Information Center at (937) 256-0194. Refer to #2675.



Rapid Coater for Laser Shock Peening

Contract Number: F33615-98-C-5116
Project Engineer: David See
Contractor: LSP Technologies Incorporated
SBIR Funded
Current Status: Active
Start Date: June 1998 End Date: September 2001

Objective

Design and build an automated paint spot application and removal device for laser shock peening, and integrate it with the existing layer system. It is also investigating optics for square beam processing and integrating this into the existing laser system. The Manufacturing Technology Division aggressively pursues advances in manufacturing technology which have broad applicability to the affordability and performance of Air Force systems. The focus of this general topic is to allow opportunities for major breakthroughs in the following areas: composites processing and fabrication, electronics processing and fabrication, metals processing and fabrication, and advanced manufacturing enterprise. New processing techniques, variability reduction tools, affordability improvements, manufacturing simulation and modeling, are a few examples of the types of proposals that are desired. The emphasis is on innovation, the ability to achieve major advances, and defense/commercial applicability.

This program will: design a device based on concepts demonstrated under Phase I; include sufficient flexibility into the device to accommodate a reasonable range of part surface geometries; integrate control of the rapid coater system into existing layer system; implement a process control imaging system to verify paint spot size and presence; integrate diffractive optical components into the beam delivery system to provide a square beam shape; integrate techniques to rapidly set up and calibrate process monitors into existing system; develop and integrate quality control monitors specific to the RapidCoater™, into the existing laser system.

The RapidCoater™ applicator head has been installed into the laser system along with the ancillary supporting system supplying water and paint to the applicator head. The system is linked into the control system with the laser and part manipulation robot. All three components are linked and work together for continuous processing. The system will operate at cyclic frequencies above one hertz. An imaging system for monitoring the paint spot has been developed. Methods for producing a square spot are being evaluated. RapidCoater™ quality control monitors are being developed. Rapid set-up techniques for the process monitors are being developed.

Benefits

Provide more affordable laser shock peening of turbine engine blades, to strengthen them and reduce the risk of foreign object damage to aircraft. The RapidCoater™ significantly increases the part throughput of the laser shock peening system. The projected increase in throughput is six to nine times current levels. The increased throughput will contribute substantially to lowering the cost of laser peening, and significantly increase the number of aerospace and industrial applications that will be able to economically benefit through increased performance using this process.

For more information on this project, contact the Manufacturing Technology Division's Technical Information Center at (937) 256-0194. Refer to #1987.

Reconfigurable Tooling

Contract Number: F33615-99-C-5310
Project Engineer: John Barnes
Contractor: Northrop Grumman Corporation
Current Status: Active
Start Date: September 1999 End Date: January 2004

Objective

Build a production-tested, computer-driven reconfigured tool (bed of nails) for use in stretch-forming aircraft sheet metal components. The sheet metal stretch forming industry is burdened with high cost tooling that typically runs $50,000 to $100,000 to produce a single part shape. Air Force depot repair operations typically produce less than 10 parts using any given tool. This creates an environment for extremely expensive parts, long production lead times and limited flexibility to changing workload demands. A process that is more responsive to customer needs is required.

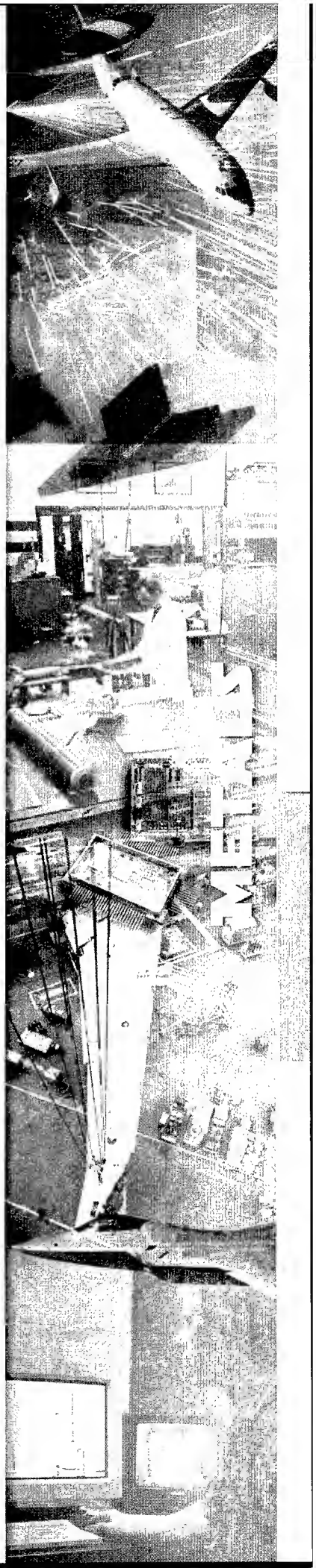
The tool will consist of 2,866 pins, each independently controllable, to form a 4-foot by 6-foot tool surface. A material inserted to prevent dimpling in the finished part will cover the pins. Simulation tools will be developed and used to take into account inserted material layer deformation, part springback, pin loading, drag forces, etc. The project is divided into nine core tasks which will be performed over a 52-month period. The first three tasks will design, fabricate, and integrate the tool, its control systems, and an Optical Shape Measurement System. The fourth task will be to demonstrate the production worthiness of the tool and its support system in the production facilities at Warner-Robins Air Logistics Center, GA. The remaining tasks will support the transfer of the system to the customer, examine the benefits of the tool, and initiate the process to other sheet metal fabrication sites in both government and commercial sites

Workload analysis is underway and the initial reconfigurable tool requirements are being established.

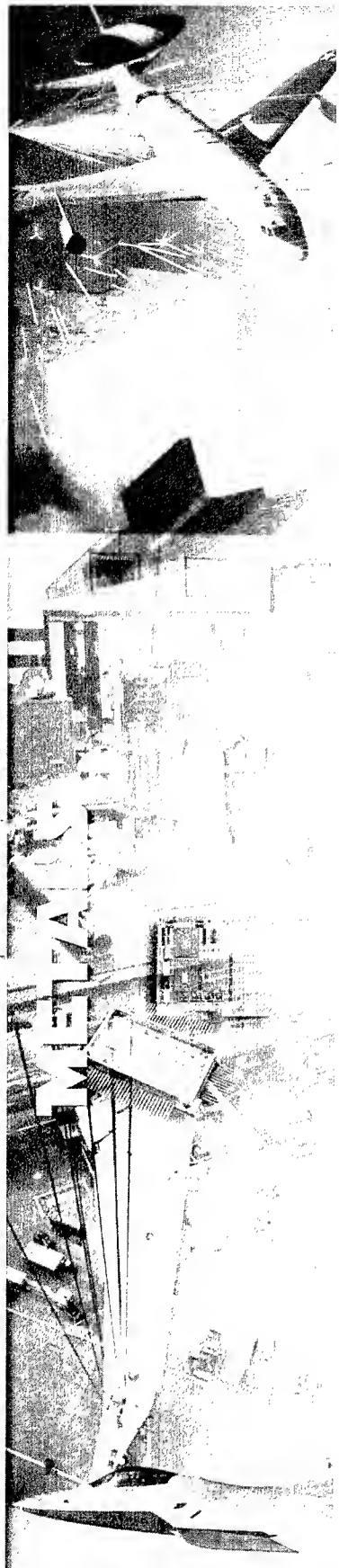
Benefits

Provide more affordable aircraft sheet metal components. One reconfigurable tool will replace in excess of 50 tools that were each fabricated to support the manufacture of one part. The cost of the reconfigurable tool will return the initial investment once 20 new single part tools have been replaced. The time to produce a new part will be reduced from several months under current methods to several days with the reconfigurable tool. Aircraft with long flying histories often have been stressed out of the original structural design shape specifications. The reconfigurable tool will increase part quality because it is minutely adjustable to account for slight deviations in part shape for specific applications.

The $6.7 million investment will return a more than $25 million cost avoidance to the Air Force over the life of the tool.



For more information on this project, contact the Manufacturing Technology Division's Technical Information Center at (937) 256-0194. Refer to #2815.



Replacement of Conventional Chrome Plating Process

Cooperative Agreement Number: F33615-99-2-5309
Project Engineer: Rafael Reed
Contractor: Wright Technology Network
Current Status: Active
Start Date: June 1999 End Date: May 2001

Objective

Develop alternative coating and plating processes that are more environmentally compliant and less costly to produce. Due to increasing stringency in Environmental Protection Agency regulations, the traditional chemical deposition method for such processes as chrome plating are rapidly becoming undesirable. This project will leverage Air Force-developed laser-based coating processes and apply them to a commercial application. The contractor will develop a new process that will solve a critical production problem. The Air Force will obtain a demonstration of an economical process that will reduce the Air Logistics Center operating cost. A quarterly report will be provided covering the following topics: a comparison of actual accomplishments with the goals and objectives established for the period, the finds of the investigator, or both; reasons why established goals were not met, if appropriate; and other pertinent information including, when appropriate, analysis and explanation of cost overruns.

Several test specimens using the laser-based coating process have been produced and are currently undergoing laboratory and field tests.

Benefits

Reduce human exposure to toxic chemicals and eliminate the requirement for chemical storage. In addition the effort should result in an overall cost reduction in the plating process by eliminating the burden associated with the disposal of hazardous waste.

For more information on this project, contact the Manufacturing Technology Division's Technical Information Center at (937) 256-0194. Refer to #2585.

Reproducible F119 Turbine Exhaust Case (TEC) Castings

Contract Number: F33615-98-C-5160
Project Engineer: Rafael Reed
Contractor: United Technologies Corporation
Current Status: Complete
Start Date: July 1998 End Date: August 2000

Objective

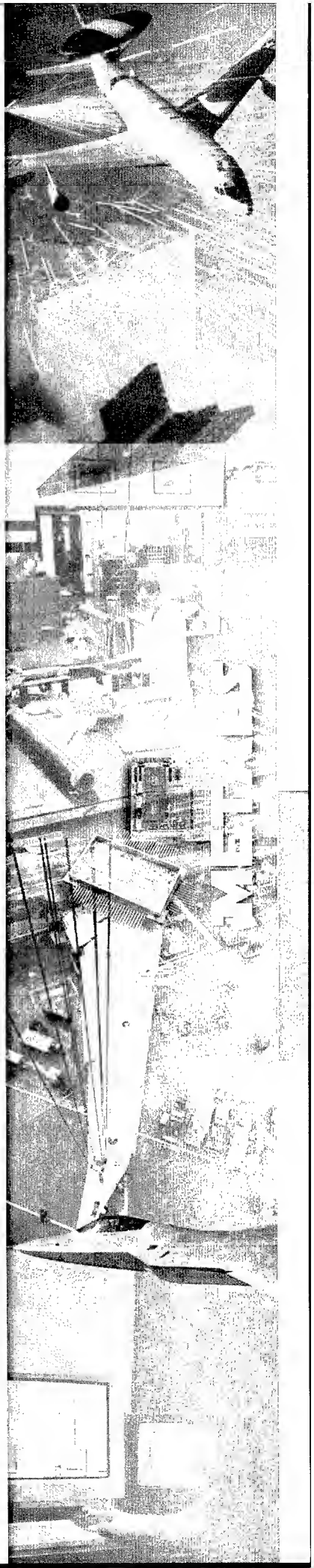
Use thin casting integral configuration technology for the F119 Turbine Exhaust Case (TEC) to address high manufacturing costs and durability shortfalls with the current bill of material sheet metal design. In addition, the contractor established a robust process with improved yields and repeatable wall thickness control in a production environment.

Preform production casting trials were conducted to validate thin-wall casting process maturation efforts. Improved wall thickness control was achieved with existing processes. Process improvements were applied to the inner diameter panel, the outer diameter panel and the vane airfoil skins. Initial hardware was provided for engine testing. Welding techniques for casting repair were investigated to improve process capability and increase production yield.

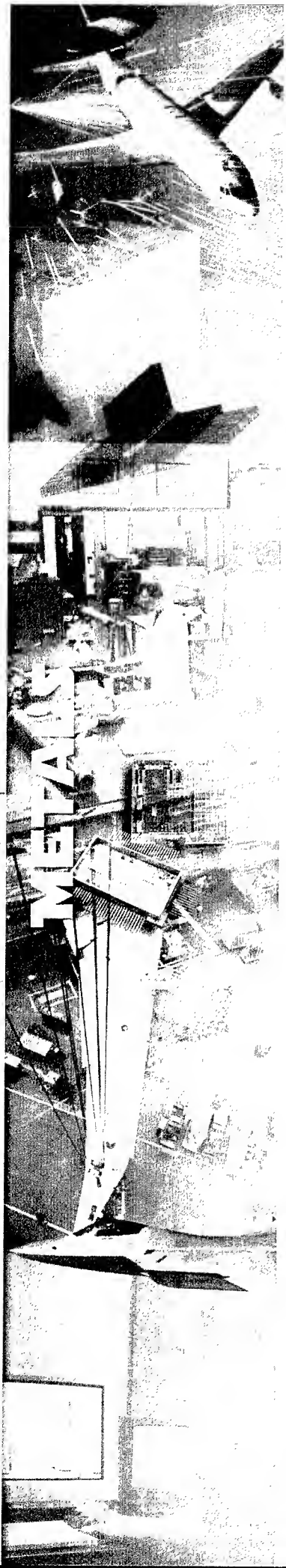
The contractor has produced and delivered TEC sets for engine testing. Process maturation has resulted in increased production yields ranging from 10 to 83 percent on all part numbers. The new TEC uses thin-wall (.025-inch wall) nickel-based castings throughout the design.

Benefits

Less expensive and more durable thin wall castings, which maintain near weight parity with the sheet metal design, will result in more affordable turbine engines for aircraft.



For more information on this project, contact the Manufacturing Technology Division's Technical Information Center at (937) 256-0194. Refer to #1781.



Structural Repair of Aging Aircraft

Cooperative Agreement Number: F33615-98-2-5113
Project Engineer: Deborah Kennedy
Contractor: The Boeing Company
Current Status: Active
Start Date: August 1998 End Date: March 2001

Objective

Develop, expand and transition the technologies, processes and procedures available to the Air Force to address the bonded structural repair of aging aircraft. It will increase the Air Force's ability to locate, quantify, repair and monitor structural cracks and corrosion. It will reduce the ambiguity in the interpretation of image-based nondestructive evaluation (NDE) data relative to crack, corrosion and bondline inspection. It will also improve confidence in bonded repair technology through advances in repair quality assurance and process control

The program will focus on four elements of structural repair of aging aircraft.

Enhance Large Area Scanning: using the MAUS IV platform; designing rotational scanning to reduce manual inspections; focusing in on wing areas; and detecting cracks/corrosion around installed fasteners using ultrasonic/ eddy current modes.

Augment Data Interpretation: using INDERS VIII Platform and fusing image-based NDE data sets.

Improve Repair Quality Measures: identifying potential in-process NDE applications for improved repair process control; developing post-process bondline inspections focusing on variations in patch geometry and bonded area; and merging image-based NDE data sets with structural analysis data using data fusion.

Validate Technology: applying existing validation processes to technology development; evaluating the full array of flaw detection needs; and coordinating with Sandia National Laboratories and University of Dayton Research Institute.

Benefits

Improve sustainment of aging aircraft by reducing cycle times associated with detection of cracks and corrosion around installed fasteners. It will reduce ambiguity in the interpretation of NDE data relative to crack and corrosion inspections. It will identify and improve repair quality measures and improve confidence in bonded repair technology through advances in process control.

For more information on this project, contact the Manufacturing Technology Division's Technical Information Center at (937) 256-0194. Refer to #1629.

Supplier Development Focused On Small and Medium Enterprises

Cooperative Agreement Number: F33615-00-2-5300
Project Engineer: Rafael Reed
Contractor: Honeywell Incorporated
Current Status: New Start
Start Date: February 2000 End Date: December 2002

Objective

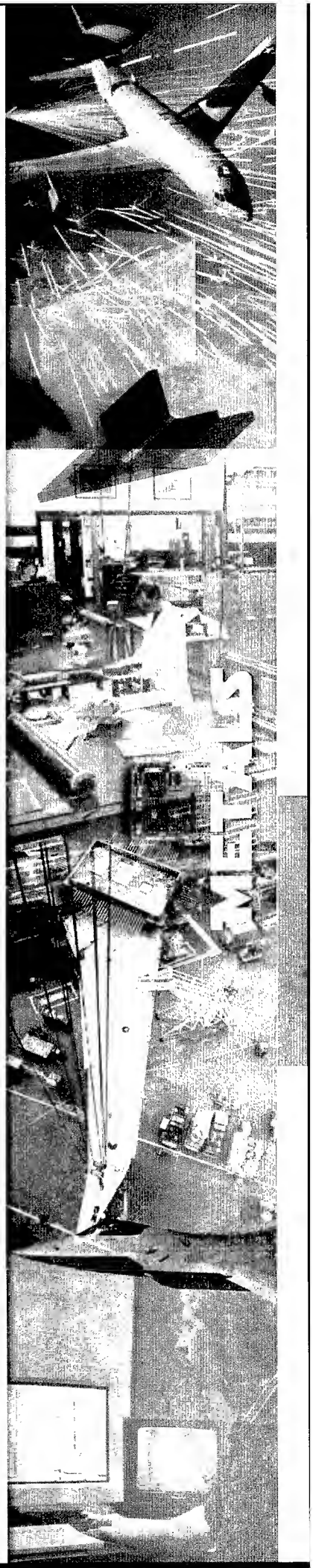
Use commercially accepted and developed best practices such as six sigma, on-time delivery, and optimized material flow to foster an atmosphere and culture of continuous improvement to reduce the overall cost of weapon systems. It will establish a business case for supplier development focused on small suppliers and special process providers. It will reach a broad cross section of small and medium suppliers with the latest productivity improvement techniques and training materials.

As much as 70 percent of the value of defense systems and major subsystems is borne in the supply chain. The percentage continues to grow with increased outsourcing of both fabrication and subassembly. Evolving supply chain management practice includes an increase in the delegation of certain functions from larger companies to their suppliers, including additional responsibilities for product development, inventory management and quality. Industrial base assessment data show that the smaller suppliers tend to lack the capabilities needed to respond to the demands for affordability and quality improvements. Small businesses may be unable to cope with the need to change due to the lack of capital, or a lack of technical resources, or both.

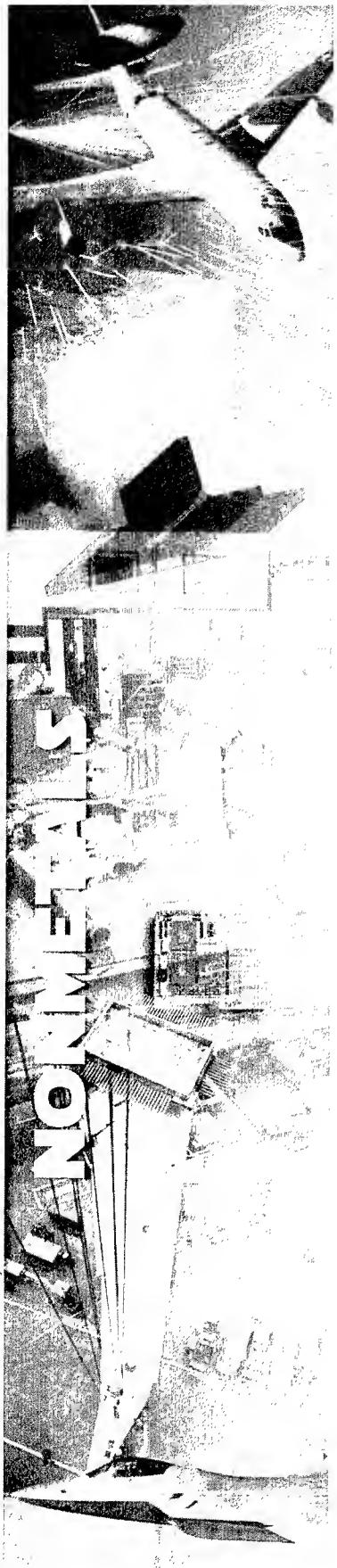
The Honeywell Engines and Systems program team has developed a new program schedule to shorten the overall program by three months. The Aerospace Academy has developed a needs assessment form to obtain background data from companies representative of possible program participants.

Benefits

More affordable military weapon systems by eliminating production waste and inefficiencies. This program will enable the second and third tier suppliers to improve material flow, increase capacity and productivity, and increase the probability of on time delivery.



For more information on this project, contact the Manufacturing Technology Division's Technical Information Center at (937) 256-0194. Refer to #2817.



Advanced Casting Technology for Low Cost Composites

Contract Number: F33615-99-C-5300
Project Engineer: Eric Becker
Contractor: Waukesha Foundry Incorporated
STTR Funded
Current Status: Active
Start Date: March 1999 End Date: February 2001

Objective

Develop a more affordable method of casting metal Invar tooling for composite structures. Composite tooling costs have been identified as a high cost area especially in the prototype environment and as production rates continue to drop. Composite cure tools must produce dimensionally accurate parts (matching coefficient of thermal expansion), be affordable, and be durable enough for production use. New technologies and methodologies are needed to develop composite processing tools that are low cost, highly durable, have compatible thermal performance characteristics, and short fabrication lead times.

There will be three main areas of investigation. Primary emphasis will be directed to further developing the patternless molding technology that was demonstrated during the Phase I effort to a production setting. The production of thinner cast face sheets will also be investigated. Analysis during Phase I has shown a potential cost savings of $160 per square foot and lead time reduction of one week when using thinner face sheets. In addition, tooling with integrally cast stiffeners will also be investigated. Integrally cast stiffeners would aid in processing of the cast face sheet and could potentially reduce costs by $40-$60 per square foot.

Waukesha Foundry Inc., has completed specification and installation of computer aided machining equipment and associated computer programs. After evaluating various spindle speeds, feed rates, depth of cut and cutter tool material for the numerically controlled cutter, it was decided to use solid carbide cutters with spindle speeds between 3000 rpm and 6000 rpm. The highest removal rate attempted was 288 cubic inches per minute, which did not stress the router motor or adversely affect the surface finish of the silica sand with pepset binder mold. Waukesha Foundry is making plate castings to guide Pro-Cast and Flow 3-D software vendors in order to match Invar simulation results to actual production castings results. Preliminary stress analysis of potential rib stiffener geometry and thinner cast face sheets is ongoing.

This technology is expected to impact the cost and lead time of any complex, low-volume casting for which pattern equipment does not exist. Machining cost, lead time, and raw materials would also be reduced for the casting of Invar face sheets. This technology would transfer to other large plate-like castings.

Benefits

More affordable weapons systems through reduced cost and leadtime of composite structures. Costs for an average metal Invar tool may be reduced by $100-$200 per square foot, and lead times decreased by three weeks. Thin cast face sheets and integrally cast stiffeners may further reduce costs.

For more information on this project, contact the Manufacturing Technology Division's Technical Information Center at (937) 256-0194. Refer to #2567.

Advanced Resin System for RTM/VARTM Processing

Contract Number: F33615-99-C-5311
Project Engineer: Dr. Frances Abrams
Contractor: Applied Poleramic Incorporated
SBIR Funded
Current Status: Complete Technical Report No.: AFRL-ML-WP-TR-2000-4065
Start Date: May 1999 End Date: February 2000

Objective

Develop new composite resins that will reduce the cost of manufacturing polymer-matrix composite structures by enabling pre-form fabrication, combined with VARTM/RTM resin infusion and out-of-autoclave curing. Finished articles could then be fabricated quickly with repeatable quality without the investment in autoclaves and their attendant maintenance and support materials. In addition, an advanced low temperature curing resin allows a whole new range of tooling materials to be used that would increase the affordability of advanced composite structures.

Resin Transfer Molding (RTM) and Vacuum Assisted Resin Transfer Molding (VARTM) processing of composite parts has been implemented on numerous commercial and military contracts. However, current applications are based on resin systems that cure at 350°F and have service temperatures in the 250-350°F range. While this is good enough for many applications, the full benefits of RTM/VARTM will not be realized without resins more tailored to the processes. Resin systems are needed that have low viscosity at room temperature for infusion, low cure temperatures (less than 180°F) for low cost tooling applications, and freestanding post cures for Electron-beam or non-autoclave curing. This topic supported the Composites Affordability Initiative (CAI), a government/industry team focused on developing the tools and technologies necessary to enable future innovative designs for composite aircraft.

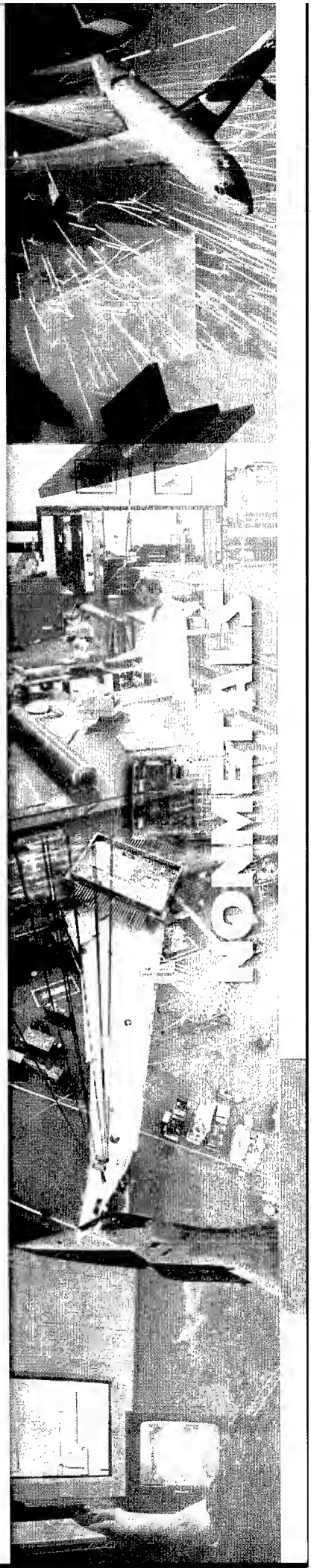
The program developed two separate resin systems: one for thermal post cure and one for using electron-beam curing. Initially, potential resin systems were determined and their process limitations documented. From there, the resins were modified for each method of post cure. At the end of the six-month technical effort, VARTM test panels were manufactured using each method of post cure and then tested.

Production success has been achieved using low performance matrix resins/composites, but the aircraft aerospace high-end quality was not been addressed. This task centered on thermal and electron beam matrix development and characterization.

Benefits

More affordable weapon systems through reduced cost of composite structures. The developed resin system will have military applications for processing of advanced composite aerospace components as well as other applications for land and sea based military craft. There is also a large commercial base in the areas of marine craft, recreational equipment, automotive, transportation, and various other markets that currently use composite RTM structures.

For more information on this project, contact the Manufacturing Technology Division's Technical Information Center at (937) 256-0194. Refer to #2560.



Advanced Resin System for RTM/VARTM Processing

Contract Number: F33615-99-C-5308
Project Engineer: Dr. Frances Abrams
Contractor: Shade Incorporated
SBIR Funded
Current Status: Complete
Start Date: May 1999 End Date: February 2000

Objective

Develop a composite resin that has adequate processing properties to allow infiltration, by VARTM or RTM, and curing at or below 180° F, and which has properties equivalent to aerospace resins now cured at 350° F.

Resin Transfer Molding (RTM) and Vacuum Assisted Resin Transfer Molding (VARTM) processing of composite parts has been implemented on numerous commercial and military contracts. However, current applications are based on resin systems that cure at 350°F and have service temperatures in the 250-350°F range. While this is good enough for many applications, the full benefits of RTM/VARTM will not be realized without resins more tailored to the processes. Resin systems are needed that have low viscosity at room temperature for infusion, low cure temperatures (less than 180°F) for low cost tooling applications, and freestanding post cures for Electron-beam or non-autoclave curing. This topic supported the Composites Affordability Initiative (CAI), a government/industry team focused on developing the tools and technologies necessary to enable future innovative designs for composite aircraft.

This Phase I Small Business Innovation Research project focused on developing a resin formulation from commercially available materials and measuring neat resin properties to determine suitability for processing and potential for mechanical performance. Resin properties that were measured include physical properties, dynamic thermal behavior during cure, rheology during cure, kinetics and, after cure, glass transition, and chemical resistance. To determine the suitability of the resin for infiltration and bonding to fiber, fiber-wetting characteristics were tested. Finally, carbon cloth composites were made in order to evaluate physical, thermal and mechanical properties.

Benefits

Better quality composite structures for future advanced weapon systems. The developed resin system will have military applications for processing of advanced composite aerospace components as well as other applications for land and sea based military craft. There is also a large commercial base in the areas of marine craft, recreational equipment, automotive, transportation, and various other markets that currently use composite RTM structures.

For more information on this project, contact the Manufacturing Technology Division's Technical Information Center at (937) 256-0194. Refer to #2559.

Affordable Manufacturing of Advanced Low Observable (LO) Coatings

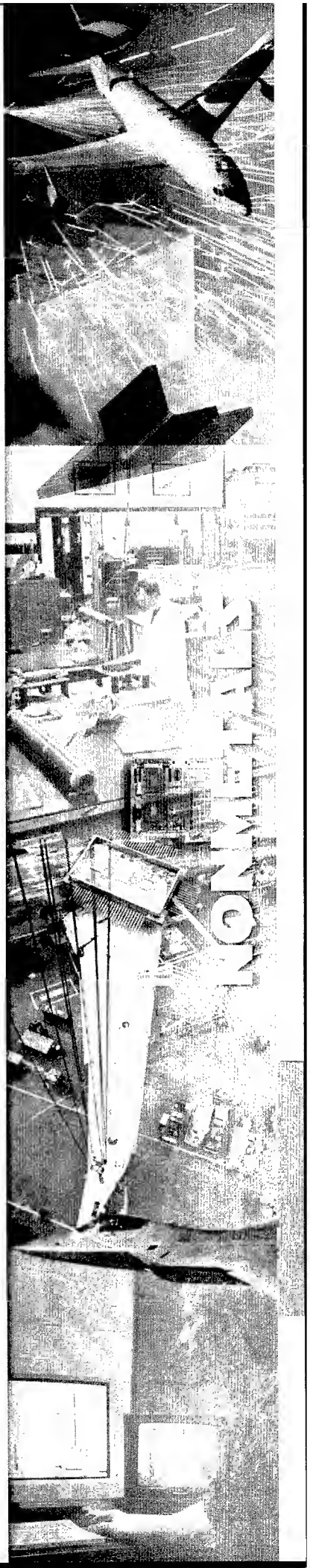
Contract Number: F33615-98-C-5165
Project Engineer: Michael Urig
Contractor: General Atomics Corporation
Current Status: Active
Start Date: September 1998 End Date: March 2002

Objective

Define, develop and demonstrate an integrated manufacturing process for the fabrication of low cost, high performance LO films and pigments for use in LO coatings products. The DoD needs a reliable source for affordable, high performance low observable (LO) thin film products.

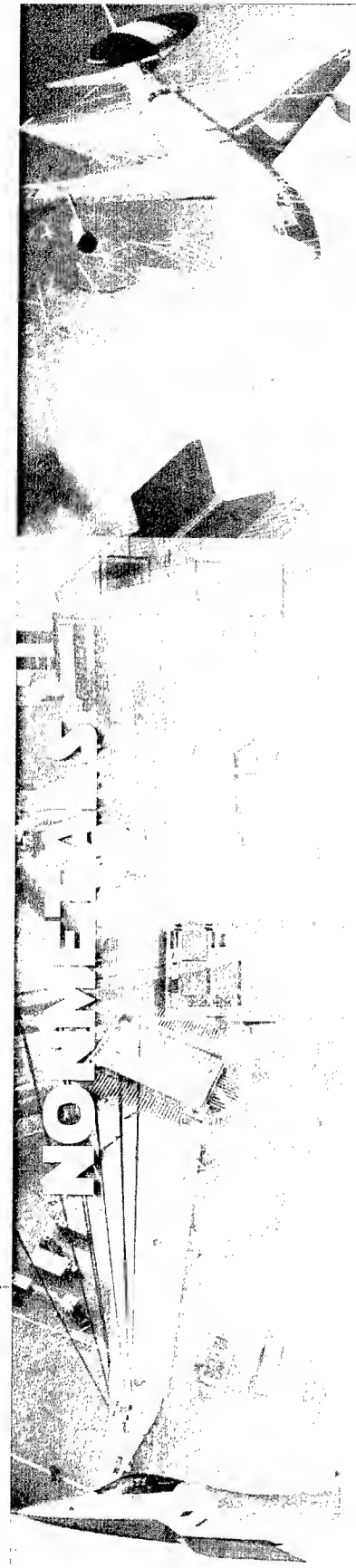
Benefits

Less risks to the warfighter through reductions in the signature of DoD weapons systems and an assured supply of affordable LO coatings.



Manufacturing Technology USAF

For more information on this project, contact the Manufacturing Technology Division's Technical Information Center at (937) 256-0194. Refer to #1801.



Affordable Tooling for Composite Structures

Contract Number: F33615-99-C-5302
Project Engineer: Eric Becker
Contractor: Production Products Manufacturing and Sales
SBIR Funded
Current Status: Active
Start Date: February 1999 End Date: February 2001

Objective

Develop a low cost tooling concept for fabricating composite structures using localized resistive heating and cast tooling technology. Of main concern currently is the ability to achieve better control of cast ceramic shrinkage, increasing the tensile strength of the ceramic molding material, and eliminating cracking in the material. Based on the findings and success of Phase I, this Phase II Small Business Innovation Research project will develop and demonstrate a 'ready for production application' low cost tooling and processing method for resin transfer molding (RTM) of composite structures. This effort will focus on future fighter applications and tie in to the Composite Affordability Initiative (CAI).

Several experiments have been performed to achieve better control of ceramic casting tool material shrinkage, tool self heating and cooling demonstrations, and tool weight reduction. The direction of this experimentation has been assisted by an analytical model of the curing process of cast silica. At the beginning of this work, the model for curing and shrinkage of cast silica was based solely on the packing density of the fused silica filler and the percent of silica in the binder material. Shrinkage was expected to be related primarily to water loss and to occur even at temperatures above that of the boiling point of water.

The associated RTM mold design and fabrication planning was initiated after selecting a sine spar component as the demonstration article. Decisions have been made for the mold pouring form of the main base, the sealing gasket form, and the clamping mechanism. Work has started on the main base of the tool, which will be cast upside-down. The pouring of this base will be accomplished in one step with the heaters and thermocouples cast in during that time. The cast part will then be used to cast the mold top and two sidepieces at a later time. Crude registration buttons will be cast into the mold, but the actual alignment pins will be located on the exterior of the mold as part of the strong-back and clamping mechanism. No cooling channels are anticipated as necessary since part curing is likely to take several hours. Natural cool down will therefore be adequate for the chosen application. Fabrication of the gasket will be made with commercially available silicone rubber o-ring material and adhesively bonded into a single part. This approach will avoid the need for an additional mold for the gasket itself and will tend to reduce resin leakage during the RTM infusion process.

Benefits

Provide more affordable weapon systems by substantially reducing tooling cost and long lead times and providing the capability to fabricate composite structures to precise dimensions. The concept developed herein will be applicable to the aerospace, medical, and automotive industries.

For more information on this project, contact the Manufacturing Technology Division's Technical Information Center at (937) 256-0194. Refer to #2558.

Affordable Tool-Less Edge Fabrication

Contract Number: F33615-99-C-5314
Project Engineer: Michael Urig
Contractor: Lockheed Martin Corporation
Current Status: Active
Start Date: September 1999 End Date: June 2001

Objective

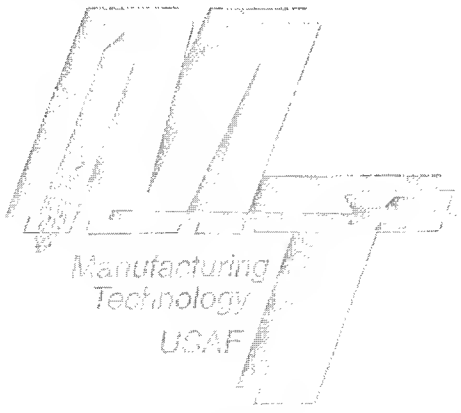
Develop an alternative process for edge fabrication that eliminates the bonding and assembly issues, and realizes a significant cost savings. The fabrication of edges for advanced low observable air vehicles involves many materials, manufacturing steps and extensive assembly operations. The resulting manufacturing process is very time consuming, expensive and often produces low quality parts. A lower cost manufacturing method is needed to improve affordability and part quality. Bonding multiple pieces together within an edge is a challenge. Part fit tolerances and bond-line thickness are very difficult to control. Any defective bonds that are found after bonding must be reworked prior to moving the edge to the next assembly cell.

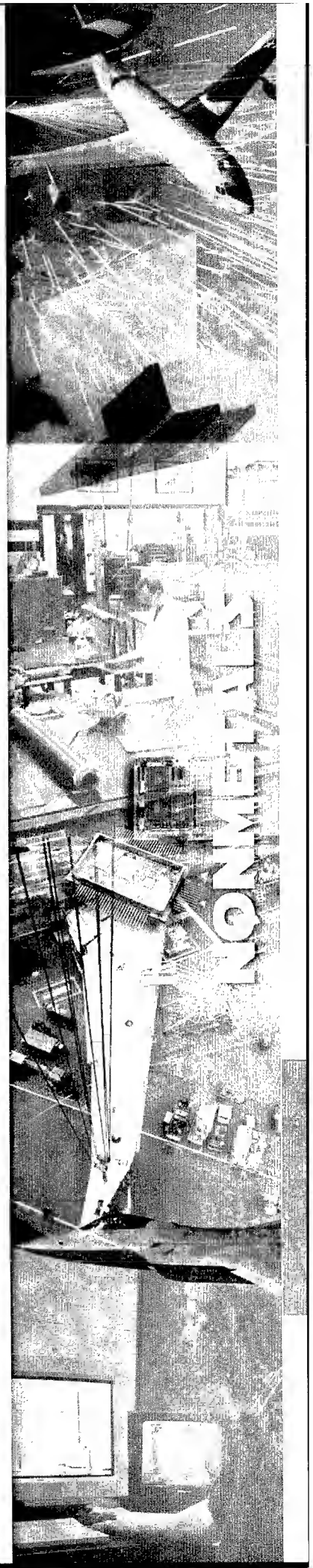
This program will demonstrate the feasibility of using Vacuum Assisted Resin Transfer Molding (VARTM) to build composite parts. This manufacturing technology is also applicable to leading edges, ailerons, flaperons and vertical leading edges. VARTM will eliminate the skin tooling, bonding fixtures and rate tooling. Fewer touch labor hours will result from eliminating checks, trimming and some inspection. Only minor changes to reduce complexity and part count will be made to the design, and any changes to pressures and cure cycles will be accounted for through testing.

This process eliminates the skin-to-core bonding step and the fabrication of closeouts, while still producing a part which meets all structural and low observable requirements. The goal is a 25 percent reduction in manufacturing cost and equal or better structural, radio frequency and radar cross section performance. Because this process does not require rate bonding tooling, production-tooling cost should also be reduced. Nondestructive inspection and rework cost should also be reduced.

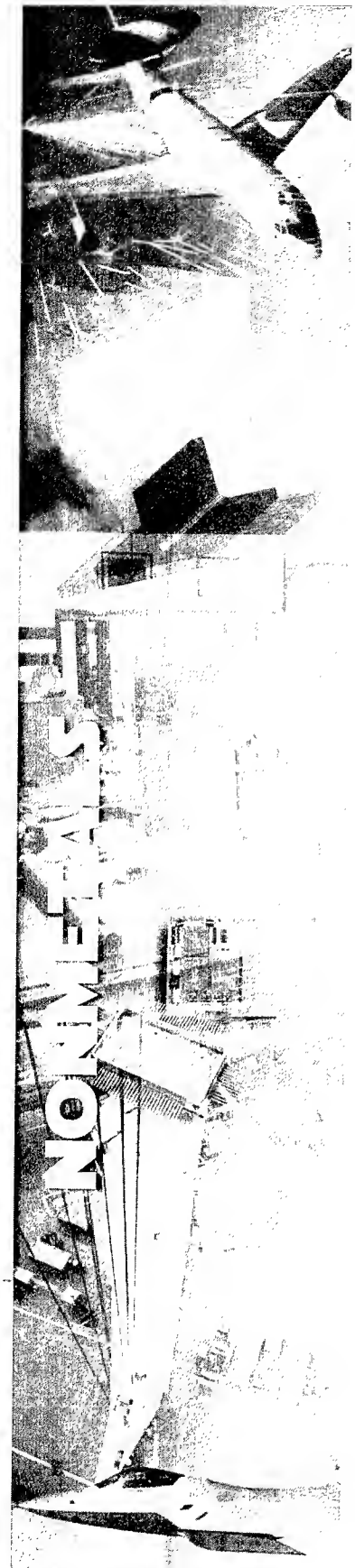
Benefits

Provide more affordable future weapon systems through significantly reducing the cost and cycle time to build composite parts.





For more information on this project, contact the Manufacturing Technology Division's Technical Information Center at (937) 256-0194. Refer to #2612.



Breathable Release Coatings for Ceramic Tooling

Contract Number: F33615-98-C-5159
Project Engineer: Eric Becker
Contractor: Utility Development Corporation
SBIR Funded
Current Status: Active
Start Date: July 1998 End Date: May 2001

Objective

Develop a high-temperature release coating system. The development of a high temperature release coating system is of great interest to Air Force contractors Lockheed Martin and Boeing Company, both of which are subcontractors on this effort. A release coating system that can be used with multiple high temperature (750°+ F) processing cycles would significantly reduce the time and cost of fabricating high temperature composite parts. This would allow the use of a re-useable low cost release coated tool (both conventional metal and castable ceramic) multiple times before having to reapply the release coating. One of the most promising considerations for cost reduction of advanced composites is improving the cost-performance of castable ceramic tooling. There are many benefits of castable ceramic tooling as compared with conventional metal tooling and other tooling methods.

Utility Development Corp. (UDC) will further improve the performance of high temperature breathable release coatings, for ceramic tooling, capable of performing reliably for multiple cycles at temperatures in excess of 800° F. This will be a continuation of the progress made in Phase I, during which UDC release coatings exhibited good release and controlled breathability for ceramic tooling at temperatures that ranged between 650° F to 700° F.

UDC has continued to formulate modified coatings in order to reduce the cure temperature of the release coating. They have evaluated a number of additives that have reduced cure temperature without affecting performance. Currently, release-coating systems that cure at about 700° F and 500° F are being evaluated for UDC by both Lockheed Martin and Boeing. Both cure temperature and adhesion between the release coating and the substrate are being improved for multiple use. In addition, work with Bell Helicopter and Composite Factory, Inc. is being established for evaluation of already developed release coatings.

Benefits

More affordable future weapon systems by reducing the time and cost required to fabricate high temperature composite parts. Improved quality and lower part cost are desired features whether the market is military or commercial. The concepts developed herein will be applicable and beneficial to the medical, aerospace and automotive industries. This program has made a significant contribution towards the high temperature processing of advanced composites and is expected to further reduce costs by using composite manufacturing tooling several times before reapplying the release coating.

For more information on this project, contact the Manufacturing Technology Division's Technical Information Center at (937) 256-0194. Refer to #1727.

Composites Affordability Initiative: Phase II - Pervasive Technology/Lockheed-Martin

Cooperative Agreement Number: F33615-98-3-5105
Project Engineer: Arthur Temmesfeld
Contractor: Lockheed Martin Tactical Aircraft Systems
Current Status: Active
Start Date: January 1998 End Date: August 2001

Objective

Significantly reduce the acquisition costs of airframe structures through the revolutionary use of composite materials. The specific goal of the Phase II effort is to develop tools and technologies to enable the design, manufacture and integration of an "all-composites" airframe with aircraft subsystems using innovative design techniques, manufacturing concepts, materials, processes and advanced business practices. These will enable breakthrough reductions in cost, schedule and weight.

The Composites Affordability Initiative (CAI) is an agreement between the government and industry to jointly attack the issues and areas of cost associated with the use of composite materials in military systems. The Air Force and the Navy are participating with the four major airframe manufacturers, Boeing Seattle, Lockheed-Martin, Northrop Grumman and Boeing St. Louis (formerly McDonnell Douglas), to address issues which cross the boundaries of cultural, business and technology domains from both the perspective of the government and industry.

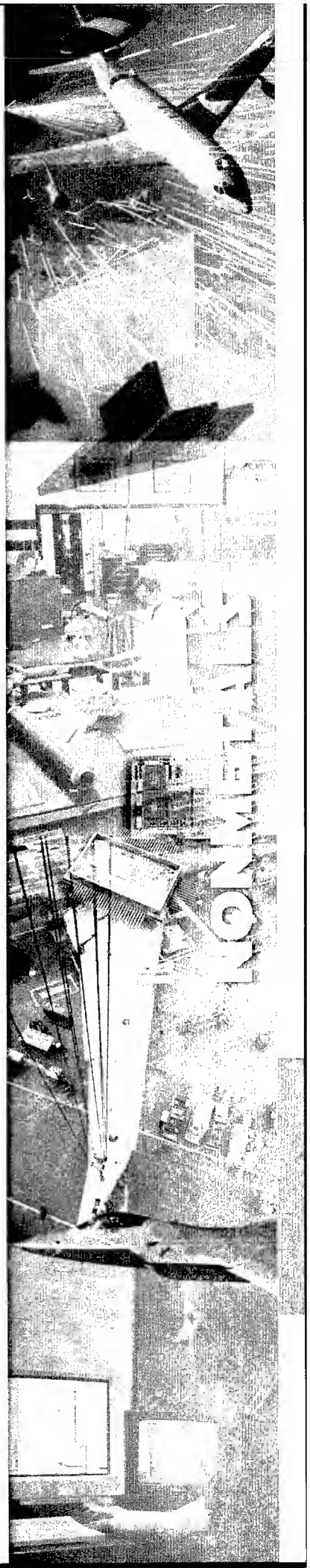
The management structure will include an Executive Council, which directs the overall CAI management effort, a Leadership Integrated Product Team (LIPT), which directs the overall technical effort, and a Systems Engineering Team (SET), which directs the effort of the individual CAI technical tasks. CAI teams will use the principles of Integrated Product Process Development to accomplish required tasks via focus activity IPTs that address specific topic areas/issues. The LIPT will have total responsibility for the direction of the effort and all the member resources assigned to the program. CAI will jointly develop and mature the essential technologies and analytical approaches to achieve major cost reduction in composites production.

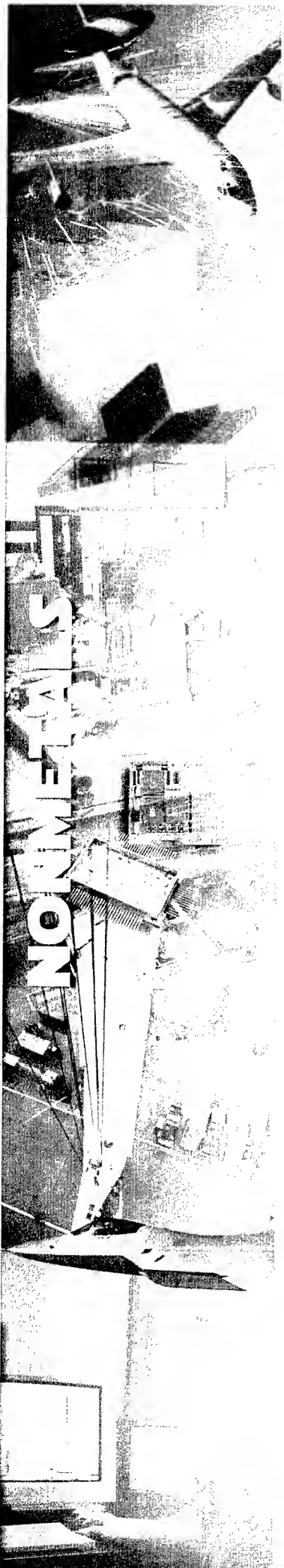
Numerous new technologies were demonstrated by the fabrication of Producibility Demonstration Articles representative of an aircraft wing structure and a forward fuselage structure. Cost studies on the manufacture of these articles and numerous other risk reduction elements were used, together with the CAI-developed cost model to predict the effect of extending these technologies on a complete airframe structure. This model predicts a 47 percent cost savings in manufacturing a structural airframe. Analytical methods were developed, calibrated and validated by joint element testing. Quality assurance methods for bonded joints and co-cured structures were developed and tested.

Benefits

Provide more affordable weapon systems by significantly reducing the acquisition costs of composite airframe structures. The CAI will result in a major reduction in the cost of composite structures and expand their use in military systems. The active involvement of all parties, collaborative planning and shared development, early and frequent demonstrations with opportunities for early transition to production is the only approach to gain wide acceptance.

For more information on this project, contact the Manufacturing Technology Division's Technical Information Center at (937) 256-0194. Refer to #1625.





Composites Affordability Initiative: Phase II - Pervasive Technology/Northrop-Grumman

Cooperative Agreement Number: F33615-98-3-5106
Project Engineer: Arthur Temmesfeld
Contractor: Northrop Grumman Military Aircraft Systems Division
Current Status: Active
Start Date: January 1998 End Date: August 2001

Objective

Significantly reduce the acquisition costs of airframe structures through the revolutionary use of composite materials. The specific goal of the Phase II effort is to develop tools and technologies to enable the design, manufacture and integration of an "all-composites" airframe with aircraft subsystems using innovative design techniques, manufacturing concepts, materials, processes and advanced business practices.

The Composites Affordability Initiative (CAI) is an agreement between the government and industry to jointly attack the issues and areas of cost associated with the use of composite materials in military systems. The Air Force and the Navy are participating with the four major airframe manufacturers, Boeing Seattle, Lockheed-Martin, Northrop Grumman and Boeing St. Louis (formerly McDonnell Douglas), to address issues which cross the boundaries of cultural, business and technology domains from both the perspective of the government and industry.

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Numerous new technologies were demonstrated by the fabrication of Producibility Demonstration Articles representative of an aircraft wing structure and a forward fuselage structure. Cost studies on the manufacture of these articles and numerous other risk reduction elements were used, together with the CAI-developed cost model to predict the effect of extending these technologies on a complete airframe structure. This model predicts a 47 percent cost savings in manufacturing a structural airframe. Analytical methods were developed, calibrated and validated by joint element testing. Quality assurance methods for bonded joints and co-cured structures were developed and tested.

Benefits

Provide more affordable weapon systems by significantly reducing the acquisition costs of composite airframe structures. The CAI will result in a major reduction in the cost of composite structures and expand their use in military systems. The active involvement of all parties, collaborative planning and shared development, early and frequent demonstrations with opportunities for early transition to production is the only approach to gain wide acceptance.

For more information on this project, contact the Manufacturing Technology Division's Technical Information Center at (937) 256-0194. Refer to #1628.

Composites Affordability Initiative: Phase II - Pervasive Technology/Boeing Seattle

Cooperative Agreement Number: F33615-98-3-5103
Project Engineer: Arthur Temmesfeld
Contractor: Boeing Company Information and Defense Systems
Current Status: Active
Start Date: January 1998 End Date: August 2001

Objective

Significantly reduce the acquisition costs of airframe structures through the revolutionary use of composite materials. The Composites Affordability Initiative (CAI) is an agreement between the government and industry to jointly attack the issues and areas of cost associated with the use of composite materials in military systems. The Air Force and the Navy are participating with the four major airframe manufacturers, Boeing Seattle, Lockheed-Martin, Northrop Grumman and Boeing St. Louis (formerly McDonnell Douglas), to address issues which cross the boundaries of cultural, business and technology domains from both the perspective of the government and industry. The specific goal of the Phase II effort is to develop tools and technologies to enable the design, manufacture and integration of an "all-composites" airframe with aircraft subsystems using innovative design techniques, manufacturing concepts, materials, processes and advanced business practices. These will enable breakthrough reductions in cost, schedule and weight.

The management structure will include an Executive Council, which directs the overall CAI management effort, a Leadership Integrated Product Team (LIPT), which directs the overall technical effort, and a Systems Engineering Team (SET), which directs the effort of the individual CAI technical tasks. CAI teams will use the principles of Integrated Product Process Development to accomplish required tasks via focus activity IPTs that address specific topic areas/issues. The LIPT will have total responsibility for the direction of the effort and all the member resources assigned to the program. CAI will jointly develop and mature the essential technologies and analytical approaches to achieve major cost reduction in composites production.

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Benefits

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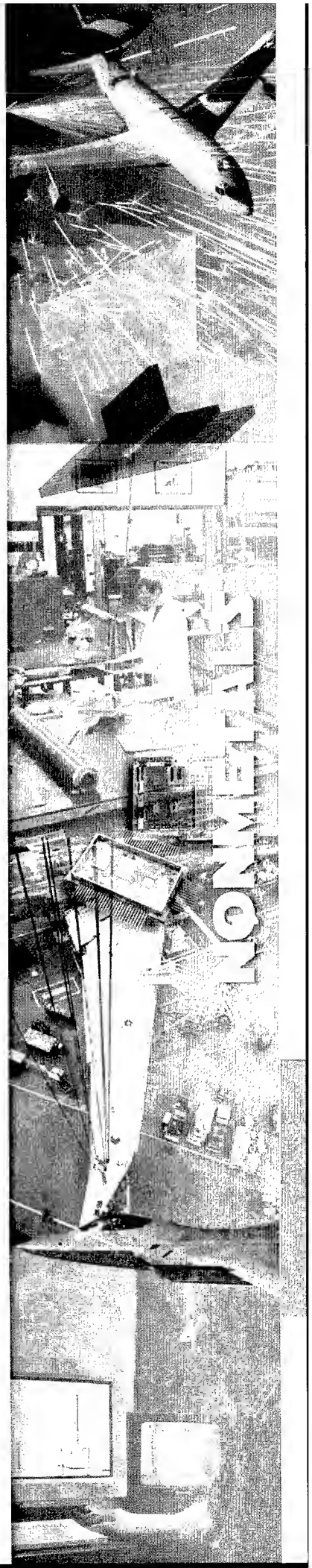
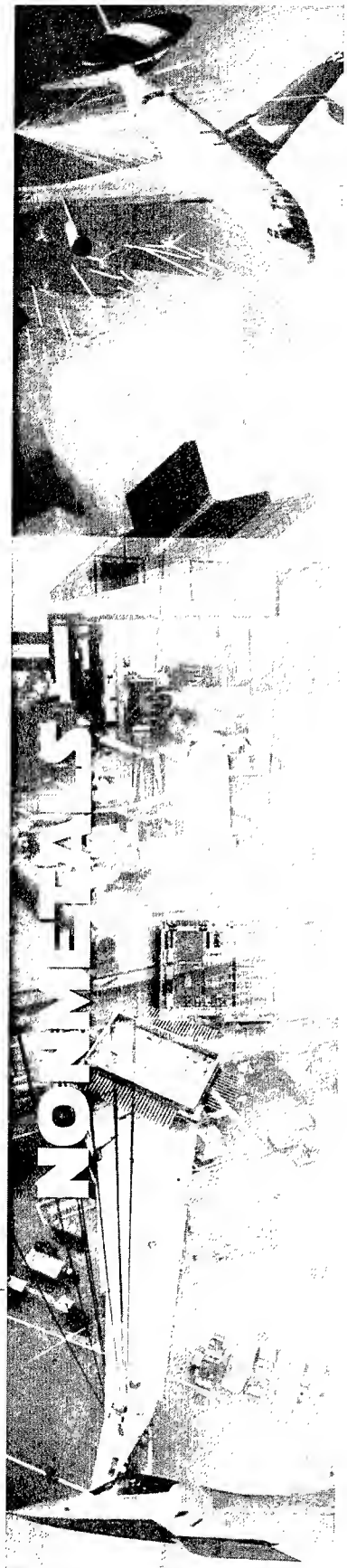


For more information on this project, contact the Manufacturing Technology Division's Technical Information Center at (937) 256-0194. Refer to #1624.



Composites Affordability Initiative: Phase II - Pervasive Technology/Boeing St. Louis

Cooperative Agreement Number: F33615-98-3-5104
Project Engineer: Arthur Temmesfeld
Contractor: McDonnell Douglas Corporation (a subsidiary of the Boeing Company)
Current Status: Active
Start Date: January 1998 End Date: August 2001

Objective

Significantly reduce the acquisition costs of airframe structures through the revolutionary use of composite materials. The specific goal of the Phase II effort is to develop tools and technologies to enable the design, manufacture and integration of an "all-composites" airframe with aircraft subsystems using innovative design techniques, manufacturing concepts, materials, processes and advanced business practices. These will enable breakthrough reductions in cost, schedule and weight.

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Benefits

Provide more affordable weapon systems by significantly reducing the acquisition costs of composite airframe structures. The CAI will result in a major reduction in the cost of composite structures and expand their use in military systems. The active involvement of all parties, collaborative planning and shared development, early and frequent demonstrations with opportunities for early transition to production is the only approach to gain wide acceptance.

For more information on this project, contact the Manufacturing Technology Division's Technical Information Center at (937) 256-0194. Refer to #1626.

Computer Enhanced Eddy Current Detection of Hidden Structures, Edges and Holes

Contract Number: F33615-98-C-5154
Project Engineer: Michael Urig
Contractor: American Research Corporation of Virginia (ARCOVA)
SBIR Funded
Current Status: Complete
Start Date: August 1998 End Date: August 2000

Objective

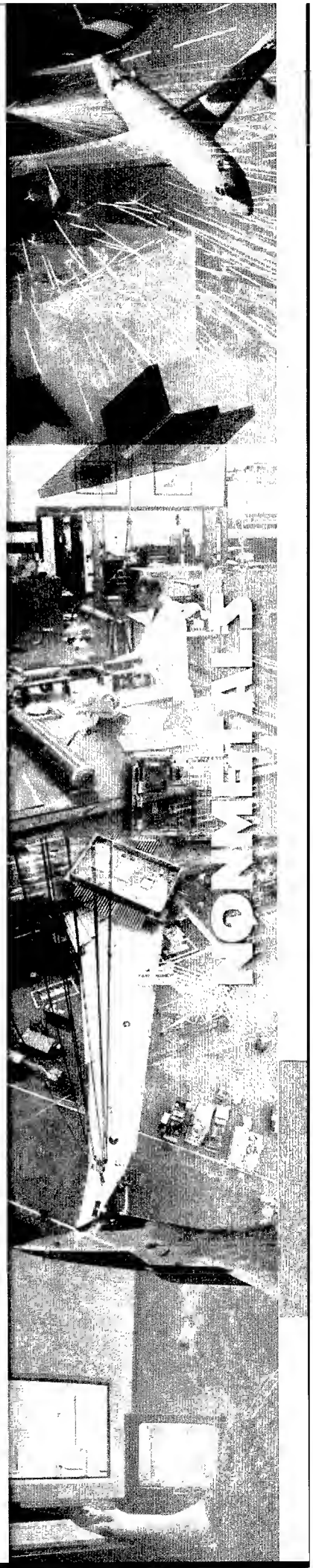
Develop a miniaturized, hand-held eddy current instrument for detecting and marking the location of hidden substructure edges and fastener holes. The ARCOVA approach integrates an eddy current sensor with a mechanical marking system to provide improved precision in locating subsurface features for assembly operations. The eddy current approach is better than non-contact methods of subsurface mapping in its ability to locate features under relatively thick surface layers. This technique can also be used to mark the surface position of a subsurface feature without loss of accuracy.

The assembly of aircraft structures involves precision alignment of skins to the substructure (bulkheads, frames, spars/ribs, etc.) prior to the drilling and filling of fastener holes. All hole locations and edge distances have tight tolerances to achieve the lightest structural weight, highest structural integrity, and the lowest radar signature. Closely matched holes that fit snugly to the fasteners at the minimum allowable distance from the panel's and substructure's edge are desired. The current methods for locating holes and edges requires the assembly technician to use hard templates or to view the assembly from the underside to mark the outer skin with edge and hole location markings. Often excess material and edge distances are required to compensate for alignment inaccuracies. Low cost innovative equipment and techniques are needed that provide accurate and timely information on the edge and hole locations. This information should include a visual display or markings to assist the aircraft assembly technician in drilling properly aligned holes and verifying edge distance requirements.

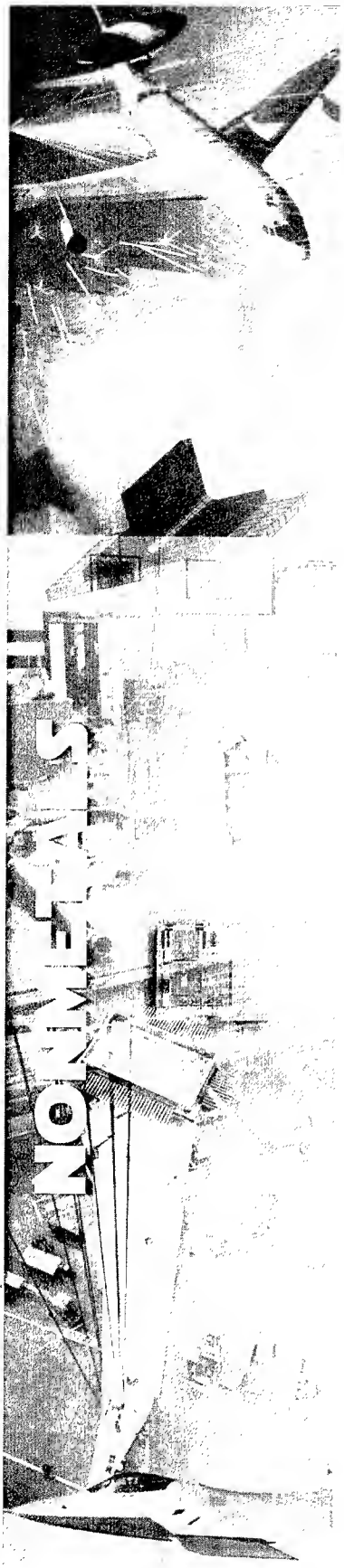
ARCOVA demonstrated the prototype instrument to Air Force personnel on 16 May 2000. This nondestructive inspection instrument was shown to be capable of meeting many of the program objectives.

Benefits

Provide more affordable aircraft for the warfighter through reduced manufacturing costs, higher quality product, reduced cycle times and the opportunity to automate aircraft assembly. Successful completion of the program objectives will result in the development of a miniaturized, hand-held digital eddy current instrument for the detection of hidden substructure edges and holes during aircraft assembly.



For more information on this project, contact the Manufacturing Technology Division's Technical Information Center at (937) 256-0194. Refer to #1729.



Design and Manufacture of Low Cost Composites (DMLCC), Bonded Wing

Contract Number: F33615-91-C-5729
Project Engineer: 2nd Lt. Joy Morrison
Contractor: Textron Corporation, Bell Helicopter
Current Status: Complete
Start Date: September 1991 End Date: March 2000

Objective

Achieve a 50 percent reduction in the manufacturing cost of advanced composite structures with an attendant 25 percent reduction in the support cost. Future weapon systems will require even greater use of composite structures to meet the increasing performance and survivability requirements. Composite structures must be reduced in both acquisition and ownership costs to enable future weapon systems to achieve the performance necessary to counter future threats. There is little opportunity to reduce the cost of advanced composite aircraft structures using existing technologies due to limitations in design concepts and methods, material properties, and manufacturing processes. Emerging, innovative new concepts, that will improve advanced composite manufacturing capabilities, will allow for innovative design techniques and reduce the acquisition cost of composite structures. New structural configurations and design analysis methods need to be developed to utilize these improved manufacturing processes in an appropriate manner. These efforts developed the design/build technology necessary to reduce the cost of wing, fuselage, and engine structures for future aircraft. Each program demonstrated the use of new emerging design, analysis, and manufacturing technologies implemented through a Concurrent Engineering/Integrated Product Development (CE/IPD) concept. The CE/IPD techniques developed within this initiative also demonstrate the capability to reduce support costs for future structures that use similar techniques.

Bell Helicopter Textron demonstrated new materials and design manufacturing concepts identified as a key to achieving a 50 percent reduction in the manufactured cost of the composite wing. The Bell concept established and implemented a new material form, the pultruded carbon rod, within a new design concept for wing stiffeners. Cost effective use of this rod was enabled through the development of the new manufacturing equipment. In addition to the implementation of the pultruded rod concept, Bell investigated all bonded construction, involving the bonding of thermoset to thermoplastic structures. Using a concurrent engineering format, Bell developed a highly integrated wing structure to reduce assembly cost. Fabrication costs were reduced by selecting the most cost effective match of manufacturing processes to structural requirements. Fabrication methods under this effort include resin transfer molding of stitched preforms and automated tape layup.

Benefits

Provide more affordable future weapon systems by reducing the acquisition costs of advanced composite structures. This program resulted in a 50 percent reduction in the manufacturing cost of advanced composite aircraft bonded wing structures which is now being incorporated into operational fleet of C-17's.

For more information on this project, contact the Manufacturing Technology Division's Technical Information Center at (937) 256-0194. Refer to #155.

Design and Manufacture of Low Cost Composites (DMLCC), Engines

Contract Number: F33615-91-C-5719
Project Engineer: Eric Becker
Contractor: General Electric Aircraft Engines
Current Status: Complete
Start Date: August 1991 End Date: May 2000

Objective

Reduce manufacturing system costs of current labor intense hand lay-up composite engine ducts by at least 50 percent, establish an IPD methodology that incorporates supportability/ maintainability criteria, and prepare an implementation plan for transitioning this technology to industry. Future weapons systems will require even greater use of composite structures to meet the increasing performance and survivability requirements. Composite structures must be reduced in both acquisition and ownership costs to enable future weapons systems. Experience indicates that decisions made early in the design phase are the most significant cost drivers for the acquisition and support costs of airframe and engine structure. This effort will provide preliminary data for these databases by designing and manufacturing innovative advanced composite engine structures. Future designers will have the access to verify cost-effective design/build methods. In order to assure that the decisions made have maximum potential to reduce acquisition cost while meeting all pertinent mission requirements, this effort will focus on concurrent engineering methods. These methods will also help to achieve the most cost-effective match of structural requirements to material properties to manufacturing processes. Emerging concepts to improve advanced composite manufacturing capability will allow for innovative design techniques to reduce the acquisition cost of composite structures. New structural configurations and design analysis methods need to be developed to use improved manufacturing processes.

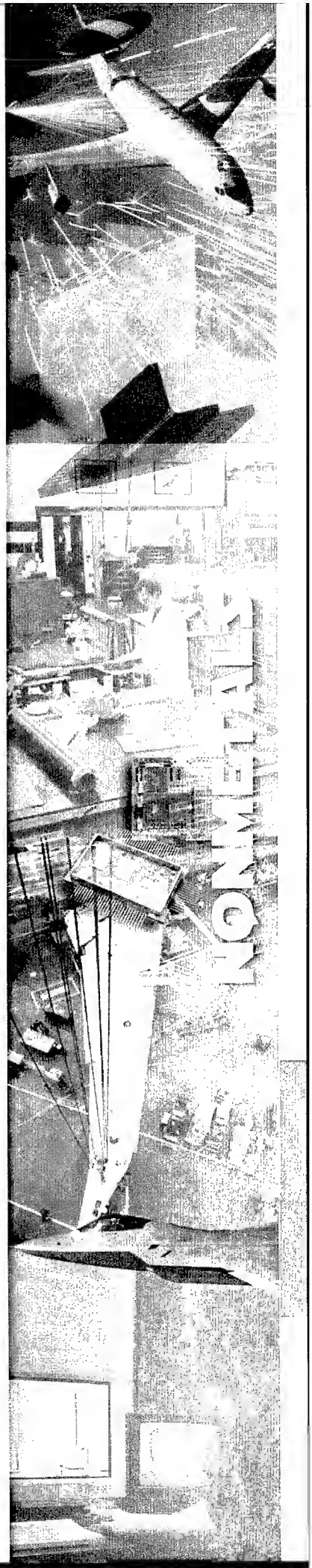
The contractor used an integrated design and manufacturing approach to promote significant cost reductions, and used the product development team approach to identify technologies that will reduce the manufactured cost of advanced composite engine structures. An overall design concept with a plan for further manufacturing development was established, with the most promising design, material form, fabrication, assembly, inspection, and concepts selected. The contractor designed, fabricated, and assembled a full-scale engine duct validation test article. Costs associated with overall fabrication and assembly were assessed and documented during this period. Projected cost reductions were compared to actual costs of fabricating the engine duct.

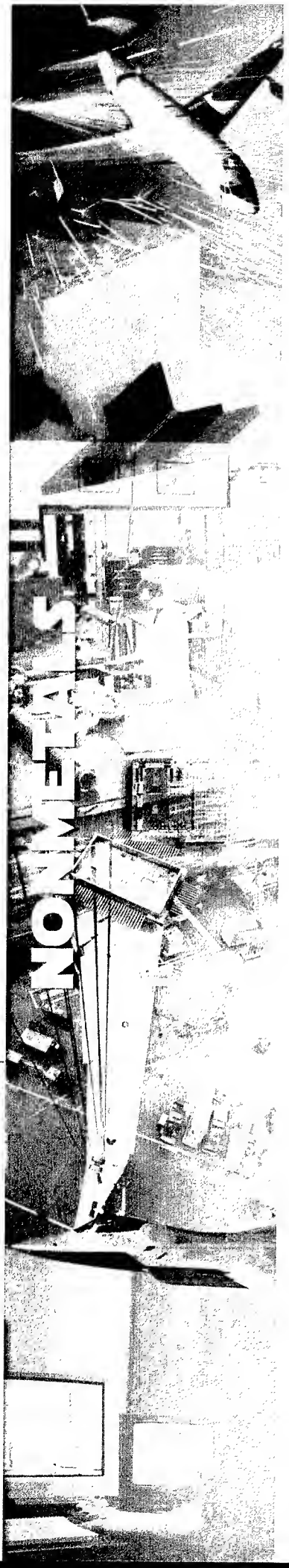
This effort demonstrated the use of novel automated manufacturing techniques such as braiding, fiber placement, and filament winding along with an integrated product design (IPD) system to assure producibility/supportability of a composite engine by-pass duct. Phase I of the program pointed to the establishment of automated fabrication processes for the manufacture of low cost composite engine ducts. Phase II focused on the scale-up and verification of the manufacturing technologies identified in Phase I.

Benefits

Provide more affordable future weapon systems by reducing the acquisition costs of advanced composite structures. This program resulted in a 50 percent direct cost savings; a two percent indirect cost savings; a reduction in quality cost controls; and transitioned braiding and fiber placement to engine duct components.

For more information on this project, contact the Manufacturing Technology Division's Technical Information Center at (937) 256-0194. Refer to #173.





Developing a Flexible Mandrel and Semi-Flexible Tooling for the Fabrication of Integrated Composite Structures

Contract Number: F33615-99-C-5301
Project Engineer: Michael Urig
Contractor: Wright Materials Research Company
SBIR Funded
Current Status: Active
Start Date: January 1999 End Date: May 2001

Objective

Develop and demonstrate an affordable tooling approach for fabricating composite parts. Organic matrix composites (OMC) are used on virtually every current and new weapon system. These OMC structures provide critical performance enhancements that enable superior weapons systems. Although organic matrix composites are used in a wide spectrum of vehicle structures, the high cost of these structures may severely limit the implementation of this critical technology to its fullest potential.

New technologies that allow for the affordable use of composite structures must be pursued. Tooling costs have been identified as a high cost area especially in the prototype environment and as production rates continue to drop. Tools for composite fabrication must produce dimensionally accurate parts, be affordable and be durable enough to meet the requirements of production use. Invar tools have been shown to meet thermal and durability requirements and are being used extensively on ongoing aircraft production programs. However, Invar tooling is very expensive and requires significant fabrication lead times. New technologies and methods are needed to develop composite processing tools that are low cost, highly durable, have compatible thermal performance characteristics, and short fabrication lead times. The new tooling technology should address the cost of fabricating both the tool face and substructure. It must provide all the capabilities of internal tooling points, scribe lines, and vacuum ports as available on the current Invar cure tools.

A reconfigurable material was developed for use in mandrel tooling. The formulation and processing of this material is being improved. Wright Materials Research has blended about 120 pounds of the mandrel materials (a mixture of structural clay, silicon rubber and modeling clay) using a two-roll mill. The material was found to contain about 4-5 percent moisture by weight. Experiments were accomplished to tailor the properties of the material. The effects of time and temperature were determined. Additional thermal-mechanical analysis and compression testing of the material is planned and it will be subjected to a simulated cure cycle for typical epoxy resins. The reusability of the material will then be determined. Northrop Grumman agreed to provide a hat-shape tool for a fabrication demonstration. A die will be designed and developed for casting the material into a hat-shape tool. This will be used in conjunction with the tool provided by Northrop to demonstrate the ability of the mandrel material.

Benefits

Provide more affordable weapon systems by reducing the cost to fabricate composite parts through cost effective manufacturing processes.

For more information on this project, contact the Manufacturing Technology Division's Technical Information Center at (937) 256-0194. Refer to #2383.

Enhanced Pultruded Composite Materials

Contract Number: F33615-96-C-5629
Project Engineer: Dr. Frances Abrams
Contractor: Rust College
Current Status: Complete Technical Report No.: AFRL-ML-WP-TR-1999-4145
Start Date: May 1996 End Date: December 1999

Objective

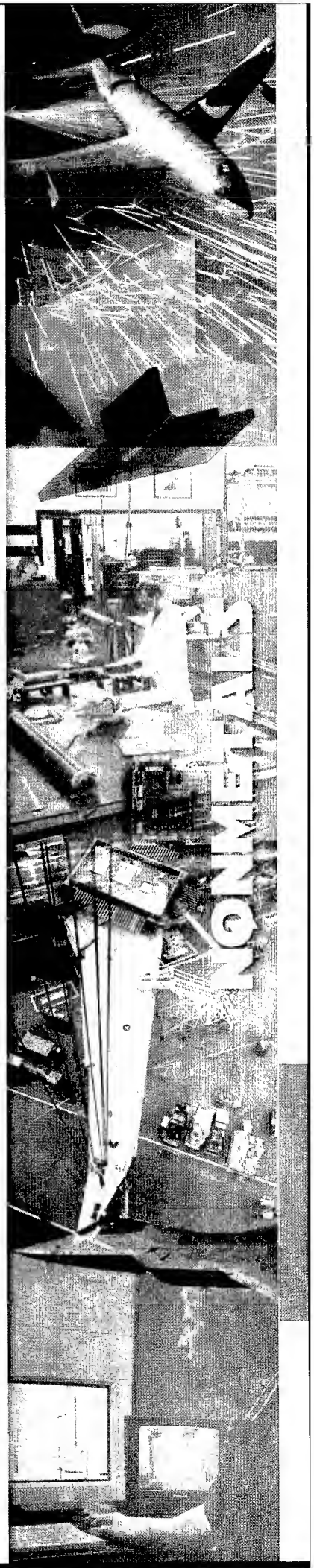
Manufacture composite materials in an optimized engineering design geometry. Most pultrusion research studies to date have examined simple pultruded shapes (e.g., simple flat or circular geometries), and have related processing conditions of these shapes to the expected mechanical properties of the composite. However, most design applications require products in more complex shapes, and unfortunately for composite materials, knowledge of composite material properties for simple shapes does not imply knowledge of the mechanical properties for the more complex shapes. Complex shaped composites need to be carefully designed for proper fiber placement and alignment, in addition to all those factors that normally affect pultruded composites.

This research addressed major expansion of the previous research to manufacture (pultrude) composite materials in optimized engineering design geometries such as I-beams, T-beams, L-beams, or hollow tubes. The use of composite materials in wide ranging design applications made the study of structural geometries necessary. The manufacture of these shapes requires the use of fiber fabric. In the past research, only unidirectional (longitudinal oriented) fibers were employed. The use of fabric provided an opportunity to vary the mechanical properties as a function of fiber orientation (direction). The research also used "hybrid" glass/graphite fiber. After manufacturing these shapes for a variety of operational pultrusion parameters (pull speed, fiber volume lay-up and hybridization, and die temperature profile), the composite materials were tested to determine the mechanical/physical properties.

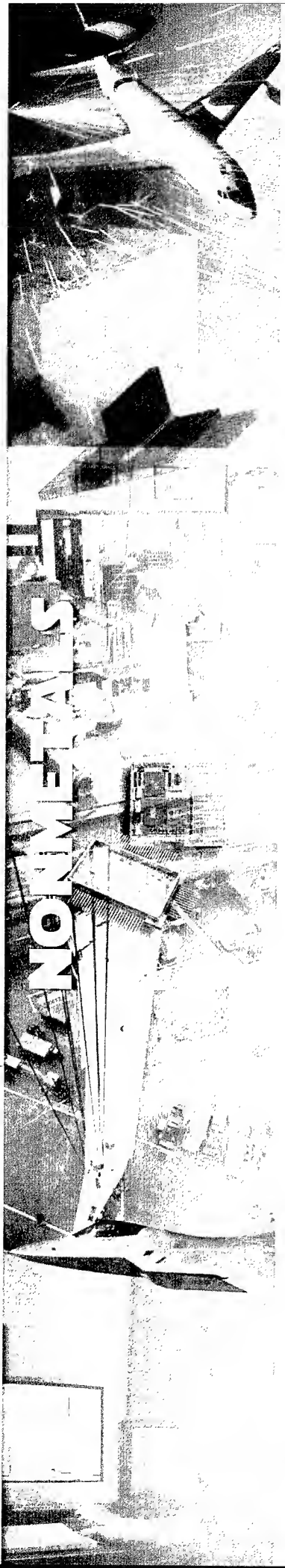
Benefits

Provide higher quality weapon systems for the warfighter, through the advancement of composite structures. This effort produced a hybrid composite using the best of both graphite and glass. The program demonstrated some of the capabilities and limits of pultrusion in the manufacturing of complex shapes. Hybrids of glass and graphite as well as parts made from each material alone were demonstrated. The hybrids performed well in the chosen application which was fabrication of tubing.

Manufacturing Technology USAF



For more information on this project, contact the Manufacturing Technology Division's Technical Information Center at (937) 256-0194. Refer to #1467.



Hybrid Composites Manufacturing Technology for Braiding/Filament Winding

Contract Number: F33615-98-C-5153
Project Engineer: Eric Becker
Contractor: A&P Technology Incorporated
SBIR Funded
Current Status: Active
Start Date: August 1998 End Date: April 2001

Objective

Combine (hybridize) braiding and filament winding processes into a single machine. Under the Air Force ManTech program Design and Manufacture of Low Cost Composites (DMLCC) – Engine, a hybrid composite manufacturing technology has been developed involving braided and filament wound preform fabrication. The braided/filament wound hybrid composites are proving to be an effective means for fabricating critical, primary load bearing jet engine structures such as the center bypass duct. This is a straight axis part involving both braiding and filament winding with multiple features. Similar work has been done demonstrating the viability of braiding for low cost composite structures in the DMLCC – Wing program, as well as in wing and fuselage structures in the National Aeronautics and Space Administration ACT program. Currently, the braiding and filament winding processes are done on separate machines, necessitating two machines, removal from one machine to the next, shipment to separate facilities, etc. By combining (hybridizing) the two processes into a single machine, significant process improvements and cost savings can be realized.

The existing braiding machine will be modified to incorporate modern control systems and software. Next, the development of the tooling, process plans, and full scale test articles will be completed in order to achieve a mature, repeatable manufacturing process. Then, structural validation tests will be performed on sub-elements and full scale test articles to validate the affordability benefits.

The hybrid braiding/filament winding work cell has been completed and full-scale test articles have been fabricated on a wooden mandrel. Three preforms have been completed to date with numerous lessons learned from each article. A fourth preform will be fabricated and then tested at the sub-element level. After these results are correlated and lessons learned identified, additional full-scale articles will be fabricated and tested at the sub-element and component level. This will validate the affordability benefits of this technology.

Benefits

Provide higher quality weapon systems for the warfighter, through the advancement of composite structures. The fully integrated multi-axis hybrid preforming system will have application in a myriad of industries. In the aerospace industry, it would be ideal for the production of the center bypass duct that has been the focus of the DMLCC – Engine program, as well as for the manufacture of nonlinear parts such as ducts and fuselage ribs. This technology would also be applicable to a variety of commercial industries such as automotive, medical (prosthetics), sports (hockey sticks, and racket sports) and recreation equipment (bicycle components).

For more information on this project, contact the Manufacturing Technology Division's Technical Information Center at (937) 256-0194. Refer to #1733.

Identification and Quantification of Structural Damage of Aging Aircraft

Cooperative Agreement Number: F33615-97-2-5151
Project Engineer: Michael Urig
Contractor: Northrop Grumman Corporation
Current Status: Complete
Start Date: October 1997 End Date: November 2000

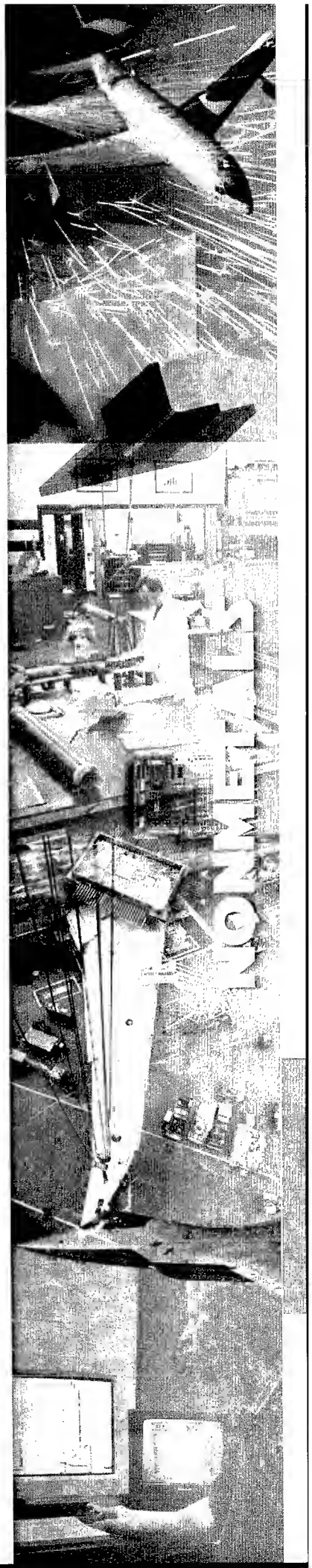
Objective

Develop, validate and deliver an automated, eddy current nondestructive evaluation system to the Air Force. The final deliverable will be a portable, field-ready inspection instrument that will rapidly detect small cracks and corrosion in complex aircraft structures. The Air Force needs improved nondestructive evaluation (NDE) capabilities to support the aging fleet of aircraft. Inspection challenges such as secondary layer crack detection around fasteners mandate better NDE processes.

The Low Frequency Eddy Current Array system design is nearing completion. Only final assembly and minor software changes remain to be completed.

Benefits

Sustainment of the Air Force's aging aircraft through development of improved NDE damage detection tools. This instrument will also have a direct and broad application within the aging commercial aircraft industry. Economic and safety improvements will be realized within both the commercial and military aircraft fleets. A significant commercial and military market is anticipated for the system due to the time and labor savings that can be realized by its implementation.



For more information on this project, contact the Manufacturing Technology Division's Technical Information Center at (937) 256-0194. Refer to #1544.

Joint Air-to-Surface Strike Missile (JASSM) Composite Body Rapid Response Process Initiative (R^2PI) Program

Contract Number: F33615-00-C-5303
Project Engineer: Art Temmesfeld
Contractor: Lockheed Martin Integrated Systems, Orlando FL
Current Status: New Start
Start Date: April 2000 End Date: March 2001

Objective

Reduce manufacturing risk to the Joint Air-to-Surface Strike Missile (JASSM) by improving the manufacturing process used to make the major components of the composite aeroshell (fuselage). The contractor will establish a new customer base (Air Armament Center), and links to the Composite Affordability Initiative (Vacuum Assisted Resin Transfer Molding/ Resin Transfer Molding) and Florida A&M University (RTM/Braiding).

The contractor will develop and implement process improvements for lower cost composite fabrication by focusing on two main areas, net braiding preform fabrication and net molding with VARTM. This effort will develop semi-automated equipment for accurate fabric cutting and improved assembly tools for complex braided composites. It will improve the Caul Plate design for product reliability and design and fabricate rapid-assembly clamps for the net edge mold JASSM Fuselage Upper Shell.

Benefits

Provide the warfighter with affordable weapons by reducing the cost of composite components. The payoff is a potential cost avoidance of $5.8 million (if fully successful) or $4.4 million (if partially successful). The benefits realized from these process improvements will be demonstrated on various JASSM parts and documented using actual cost and schedule data.

For more information on this project, contact the Manufacturing Technology Division's Technical Information Center at (937) 256-0194. Refer to #2691.

Manufacturing Technology for Multifunctional Radomes

Contract Number: F33615-93-C-4312
Project Engineer: Michael Urig
Contractor: Lockheed Martin Corporation
Current Status: Active
Start Date: September 1993 End Date: March 2001

Objective

Establish and validate reproducible and affordable processes for the manufacture of low observable radomes. The specific goals are to meet current performance specifications while reducing the production costs, assembly variability, and production risks. This technology development is applicable to the retrofit of radomes for existing aircraft as well as advanced fighters with low radar cross-section.

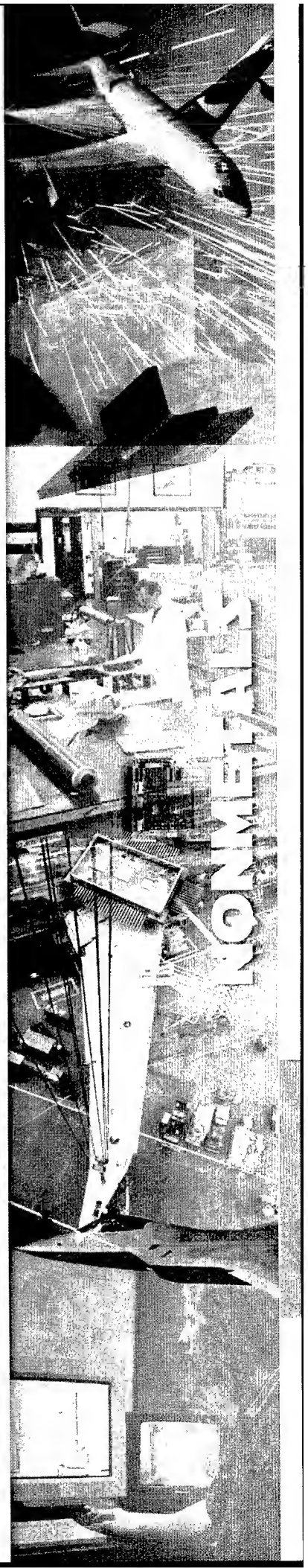
Multifunctional structures pose many unique and challenging problems related to manufacturing and assembly issues associated with low radar cross section radomes. These challenges include: processing low loss dielectric materials, fabricating multi-layer sandwich structures, and meeting very stringent requirements for radar frequency (RF), radar cross section (RCS), structural integrity, and lightning strike protection. This program examines the unique fabrication and assembly problems associated with low RCS radomes.

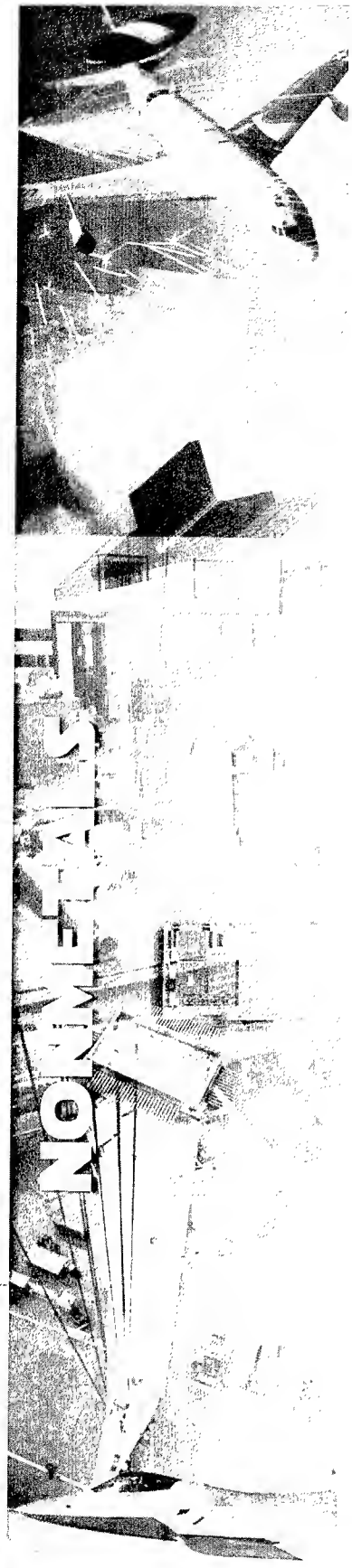
To reach the objectives, a four-phase effort was defined. The first phase evaluated alternative manufacturing processes using new, low-loss, low-dielectric materials. During this phase the electrical performance of the selected materials and construction were defined. Additionally, a cost-benefit analysis was conducted and projected savings were compared to the baseline structure. The second phase provided manufacturing verification by using the materials and concepts from Phase I to define tooling and assembly approaches. A full-scale radome was manufactured. Costs were tracked to provide a benchmark for measuring progress in realizing the projected cost and producibility benefits. In the third phase, additional full-scale components were fabricated using the materials, methods, tooling and assembly techniques established in Phase II. Testing was conducted and the results were compared to requirements. The objective of the fourth phase is to develop and demonstrate repair processes for the radome.

Benefits

Provide more protection to the warfighter through development of affordable, low-observable radomes. This effort offers cost-effective solutions to the unique fabrication and assembly challenges associated with low RCS radomes. The approach demonstrated under this effort will meet or exceed all current specifications, and provide for a 30 percent reduction in acquisition cost and a 50 percent reduction in assembly span time over the baseline process.

For more information on this project, contact the Manufacturing Technology Division's Technical Information Center at (937) 256-0194. Refer to #655.





Microwave Curing for Reversible Bonding of Composites

Contract Number: F33615-98-C-5115
Project Engineer: Dr. Frances Abrams
Contractor: Aerotech Engineering & Research Company
SBIR Funded
Current Status: Complete
Start Date: April 1998 End Date: July 2000

Objective

Use Reversible Polymeric Adhesive Bonding using variable frequency microwave energy (MW). This would allow military and civilian aircraft manufacturers and operators to assemble, inspect and maintain their aircraft more cost-effectively.

During Phase I, Aerotech and its partner, The Department of Energy's Oak Ridge National Laboratory's (ORNL) Center for Manufacturing Technology, bonded and debonded over 200 glass/epoxy substrates, proving the feasibility of this technology. During Phase II the technology was extended to carbon substrates and special formulations of thermoplastic adhesives for low and high end-use temperatures were developed. ORNL has chosen to focus their efforts on the use of induction energy instead of microwave energy for the bonding process and has stopped work on this process. ORNL has successfully transferred the microwave equipment technology to Aerotech. Aerotech is currently negotiating with the Air Force to modify the contract so that funds originally intended to be spent by ORNL can be used at Aerotech instead to build and test some specimens using glass adherands and graphite filled adhesives.

Benefits

Provide more affordable weapon systems through the development of advanced composite structures. Variable Frequency Microwave Radiation (VFMW) has been shown to produce more uniform heating of parts which ensures reduced thermal stress; reduced warping and controlled bubble formation. One of the main advantages of using microwave heating for thermoplastics adhesive curing is that the process is reversible.

For more information on this project, contact the Manufacturing Technology Division's Technical Information Center at (937) 256-0194. Refer to #2215.

Laser Eye Protection (LEP)

Cooperative Agreement Number: To Be Determined (TBD)
Project Engineer: Raymond Linville
Contractor: TBD
Defense Production Act Title III Funded
Current Status: Projected
Start Date: TBD End Date: TBD

Objective

Establish a highly responsive, affordable production capacity for thin film dielectric coatings on polycarbonate to make laser protective eyewear meeting defense needs. This project will assure that domestic producers are available to supply these devices in sufficient quantities to protect military personnel from laser threats and at affordable prices. Warfighters are highly susceptible to mission-compromising impairment and permanent eye damage from rapidly proliferating sources of laser threats and friendly force hazards. Commands in each of the services have high priority efforts in the development, demonstration, and procurement of LEP. Potential commercial uses include protection for medical and industrial personnel who work with lasers, as well as protection for police and commercial pilots as laser illuminators proliferate.

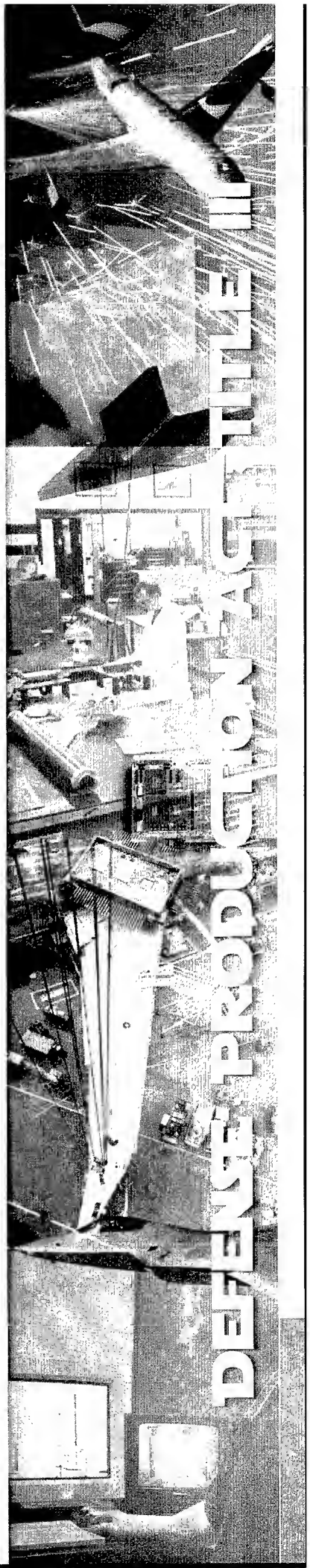
Title III financial incentives will be used to establish a flexible manufacturing capability of at least 30,000 units per year to meet service requirements for LEP. The project will require cost sharing, business and marketing plans, cost and process variability reduction, along with evaluation and qualification to service requirements. Purchases and purchase commitments will provide incentives for capital equipment and qualification. To ensure that the requirements of each service are met, scientists, engineers and program managers will provide technical assistance to the Title III Program Office from the AFRL Materials and Manufacturing Directorate, Air Force Life Support System Program Office, U.S. Army Soldier Systems Command, and the Naval Air Warfare Center.

LEP is essential to today's warfighters. This project will reduce the technical risk of manufacturing and improve the quality of LEP, lower per unit cost, increase responsiveness and flexibility to manufacture LEP at reduced lead times, and assure a responsive supply to meet changing threats and hazards.

Benefits

Provide a less expensive and more protective coatings system for canopies to protect the warfighter from laser threats which are becoming more proliferated and at greater levels.

For more information on this project, contact the Manufacturing Technology Division's Technical Information Center at (937) 256-0194. Refer to #1878.



Power Semiconductor Switching Devices (PSSDs)

Contract Number: F33615-98-C-5853
Project Engineer: Raymond Linville
Contractor: Silicon Power Corporation
Defense Production Act Title III Funded
Current Status: Active
Start Date: August 1998 End Date: August 2003

Objective

Remove a major barrier to producing aircraft, ships, and tanks that use electrical systems to replace hydraulic systems, as well as directed energy weapons, and electromagnetic launchers. Power Semiconductor Switching Devices (PSSDs) are solid-state components that replace current electromechanical switches, increasing switching efficiency and power handling capability while reducing acquisition and life-cycle costs. PSSDs are essential to the development and deployment of advanced Air Force, Navy, and Army weapon systems. This project will remove a major barrier to producing aircraft, ships, and tanks that use electrical systems to replace hydraulic systems, as well as directed energy weapons, and electromagnetic launchers.

The scope of this project includes technical, marketing and business efforts required to establish a viable business to provide Department of Defense with assured access to PSSDs. The contractor will complete business analysis and planning, perform market analysis, establish a production capacity, perform continuous product and process improvement, establish device cost and price, and have customers evaluate and qualify devices.

Benefits

Provide a family of high-quality power electronic devices to meet demanding military and commercial electrical power switching, control, and conditioning applications. This will allow fleet-wide weapon system modernization of electrical subsystems, replacing aging and hard-to-maintain hydraulic subsystems.

For more information on this project, contact the Manufacturing Technology Division's Technical Information Center at (937) 256-0194. Refer to #1501.

Semi-Insulating Indium Phosphide Wafers

Contract Number: F33733-97-C-1022
Project Engineer: John Blevins
Contractor: American Xtal Technology
Defense Production Act Title III Funded
Current Status: Complete
Start Date: May 1997 End Date: January 2000

Objective

Establish an economically viable production capability for semi-insulating Indium Phosphide (InP) wafers. InP is a compound semiconductor material that is critical to a variety of optoelectronic and very-high-frequency, millimeter wave, and high power microwave electronics. The Department of Defense (DoD) is investing heavily in the development of InP based devices. However, the manufacturing infrastructure for InP wafer production is not capable of meeting DoD requirements with respect to quality, price, size and availability. Increased domestic production capacity for InP is required to support current and future needs for both military and commercial applications. The objective of this project was to establish a viable, long-term, world class manufacturing capability for InP wafers. The effort was comprised of eight tasks which included aggressive marketing and business development, optimizations of crystal and wafer (75mm) growth processes, cost reduction, production scaleup, material qualification, wafer distribution and establishment of a 100mm production process.

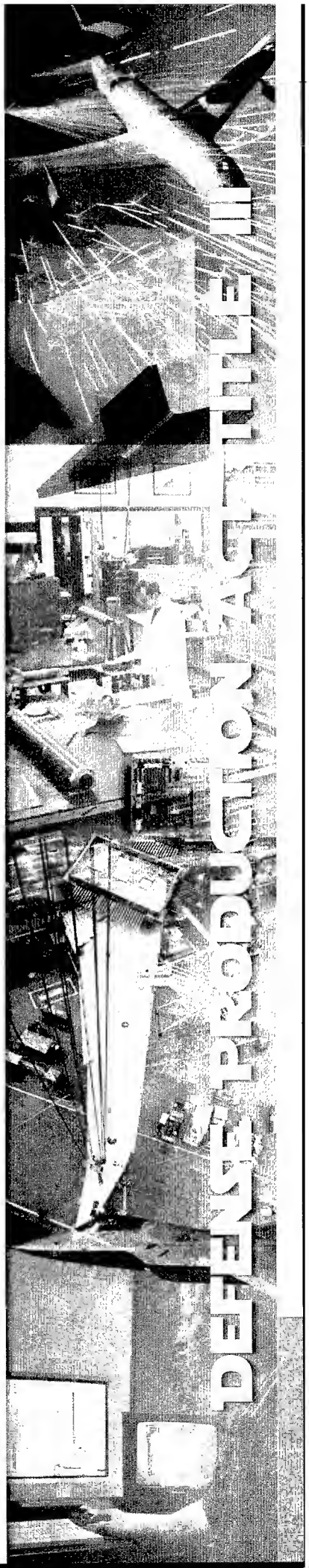
AXT demonstrated the applicability and scalability of InP growth technology. They built upon early AFRL developmental work and made very dramatic progress in becoming an acknowledged leader in the manufacture and supply of low-defect, large diameter InP wafers. In conjunction with its Title III contract, AXT assumed a world leadership position as a supplier of 100mm InP wafers. This achievement is particularly significant because the merchant availability of 100mm material is critical to the continued acceptance and use of InP by commercial suppliers.

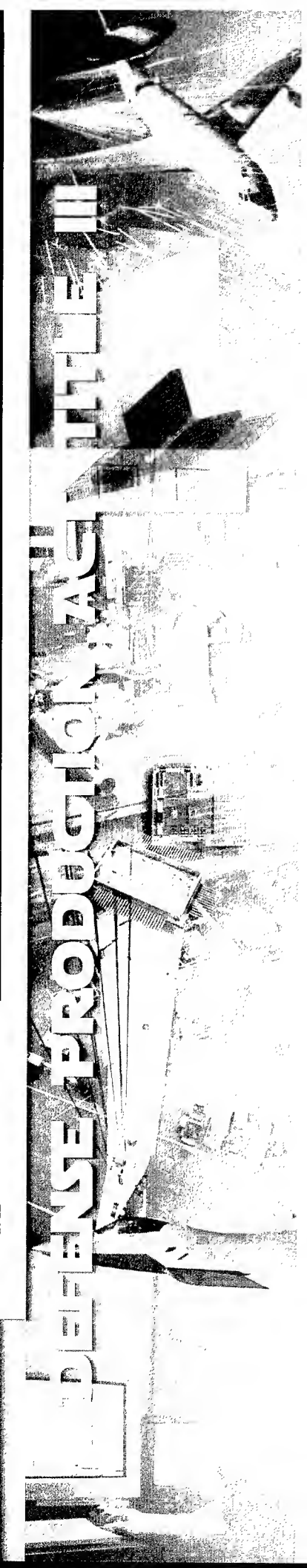
Benefits

Successfully reduced the production cost for 100mm InP wafers by 50 percent and ensured the DoD will maintain a reliable source of high quality wafers at the lowest possible price. The Indium Phosphide Wafer Project will have a far-reaching impact on the Air Force, DoD and the commercial marketplace for several years to come, saving millions for weapons systems alone.

Manufacturing Technology USAF

For more information on this project, contact the Manufacturing Technology Division's Technical Information Center at (937) 256-0194. Refer to #1502.





Semi-Insulating Indium Phosphide Wafers

Contract Number: F33733-97-C-1023
Project Engineer: John Blevins
Contractor: M/A-COM Incorporated
Defense Production Act Title III Funded
Current Status: Complete
Start Date: May 1997 End Date: May 2000

Objective

Establish an economically viable production capability for semi-insulating Indium Phosphide (InP) wafers. InP is a compound semiconductor material that is critical to a variety of optoelectronic and very-high-frequency, millimeter wave, and high power microwave electronics. The Department of Defense (DoD) is investing heavily in the development of InP based devices. However, the manufacturing infrastructure for InP wafers production is not capable of meeting DoD requirements with respect to quality, price, size and availability. Increased domestic production capacity for InP is required to support current and future needs for both military and commercial applications. The objective of this project was to establish a viable, long-term, world class manufacturing capability for InP. The effort was comprised of eight tasks which included aggressive marketing and business development, optimizations of crystal and wafer (75mm) growth processes, cost reduction, production scaleup, material qualification, wafer distribution and establishment of a 100mm production process.

Benefits

Successfully reduced the production cost for 75mm InP wafers by 50 percent and ensured the DoD will maintain a reliable source of high quality wafers at the lowest possible price. The Indium Phosphide Wafer Project will have a far-reaching impact on the Air Force, DoD and the commercial marketplace for several years to come, saving millions for weapon systems alone.

For more information on this project, contact the Manufacturing Technology Division's Technical Information Center at (937) 256-0194. Refer to #1549.

Titanium Matrix Composite Turbine Engine Component Consortium (TMCTECC)

Cooperative Agreement Number: F33615-94-2-4439
Project Engineer: Kevin Spitzer
Contractor: Pratt & Whitney
Defense Production Act Title III Funded
Current Status: Active
Start Date: August 1994 End Date: December 2001

Objective

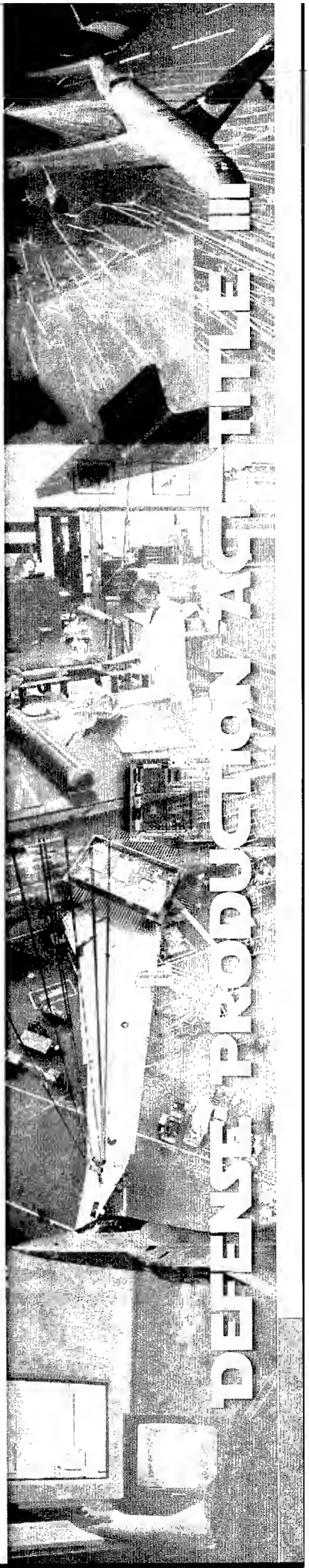
Mature the titanium matrix composites (TMC) fabrication industry and deploy TMC's in advanced gas turbine engines. Modern aircraft performance is directly related to thrust-to-weight ratio of engines and the combined weight of the aircraft structure, systems, subsystems, and fuel. Titanium matrix composites (TMC) can provide engine manufacturers and aircraft companies the capability of significantly reducing weight while providing increased performance. Unfortunately, these materials are very expensive and the production base does not exist to affordably and routinely produce affordable, high quality components. The Titanium Matrix Composite Turbine Engine Components Consortium (TMCTECC) is a pre-competitive industry consortium consisting of Atlantic Research Corporation, Textron Systems, Pratt & Whitney, General Electric Aircraft Engines, and Howmet Corporation. This work will be done in a manner that should assure the TMC supplier community is self-sustaining without the need for government subsidy at program completion. This will facilitate the ready availability of TMC material for a variety of defense and commercial applications. TMCTECC will implement TMC material into a sufficient number of components to stabilize the industry. A manufacturing base capable of producing 15,000 pounds per year can readily support the relatively small volumes anticipated for use in all engines/applications in the foreseeable future. The specific Phase II program goal of an annual capacity above 2,500 pounds was demonstrated.

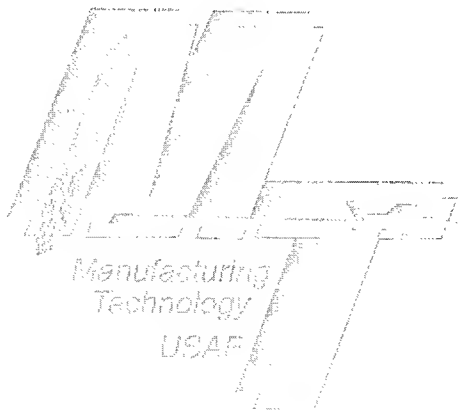
The TMCTECC team is considering production of nozzle actuator piston rods for the Pratt & Whitney F119 engine and exhaust nozzle links for General Electric's F110 Engine. Pratt & Whitney continues to work with the TMC material suppliers to reduce the cost of the F119 piston rod. An alternate low cost piston rod has been designed and manufactured and is currently undergoing qualification testing. For the GE F110 link, the project office has issued a class II change in design to incorporate the TMC reinforced exhaust nozzle compression link in the F110-100, 100A, 100B and 129 engines. The GE F110-132 project announced their plan to incorporate the link. This means that the demand for the link over the next 8-10 years could exceed 20,000 parts. Realization of this level of TMC link production will depend on the ability to meet cost reduction objectives planned during the production of the links under the TMCTECC Title III Program. In addition the team has designed, fabricated, and furnished a low-pressure turbine shaft to General Electric for engine testing.

Benefits

Provide a viable TMC supplier base for military and commercial applications requiring affordable TMC reinforced gas turbine hardware. The warfighter will benefit from weapon systems with increased range, payload, and fuel efficiency.

For more information on this project, contact the Manufacturing Technology Division's Technical Information Center at (937) 256-0194. Refer to #1286.

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